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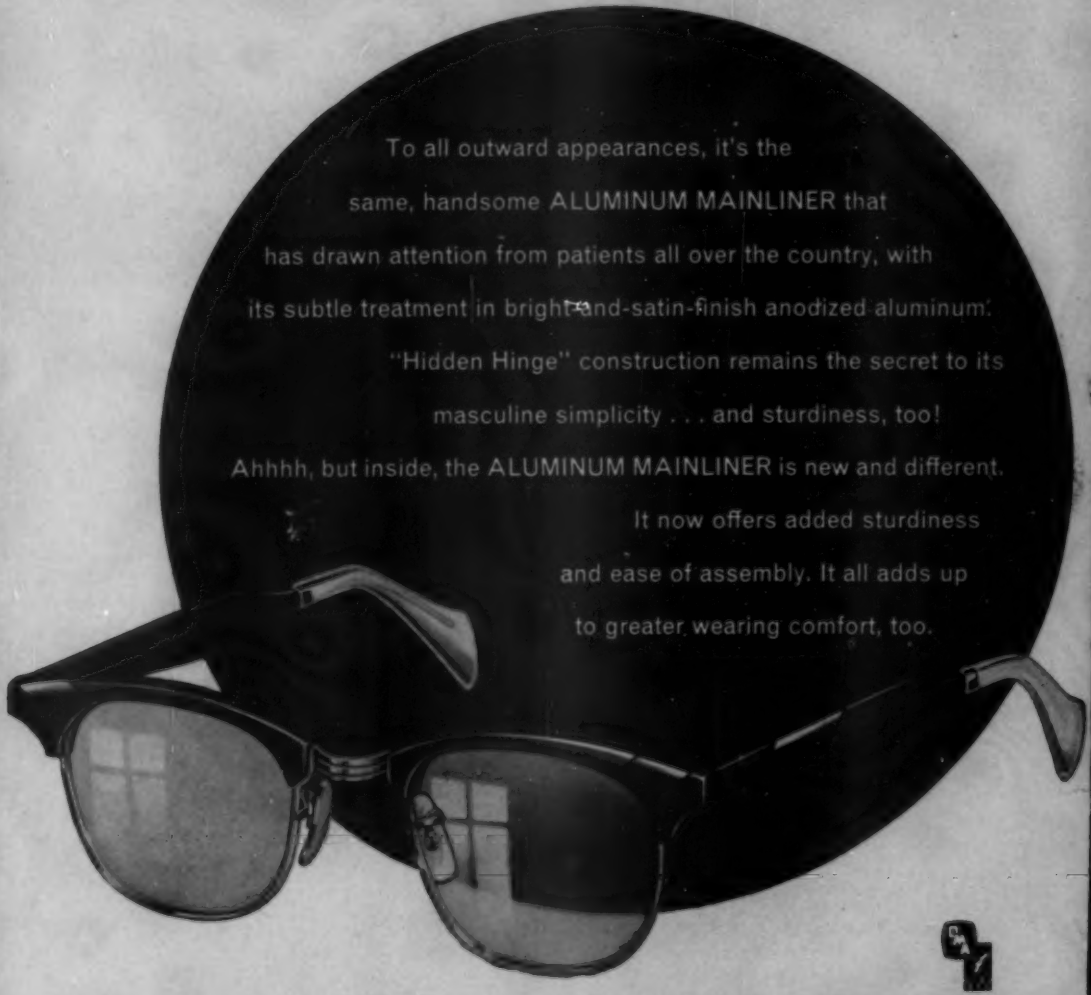

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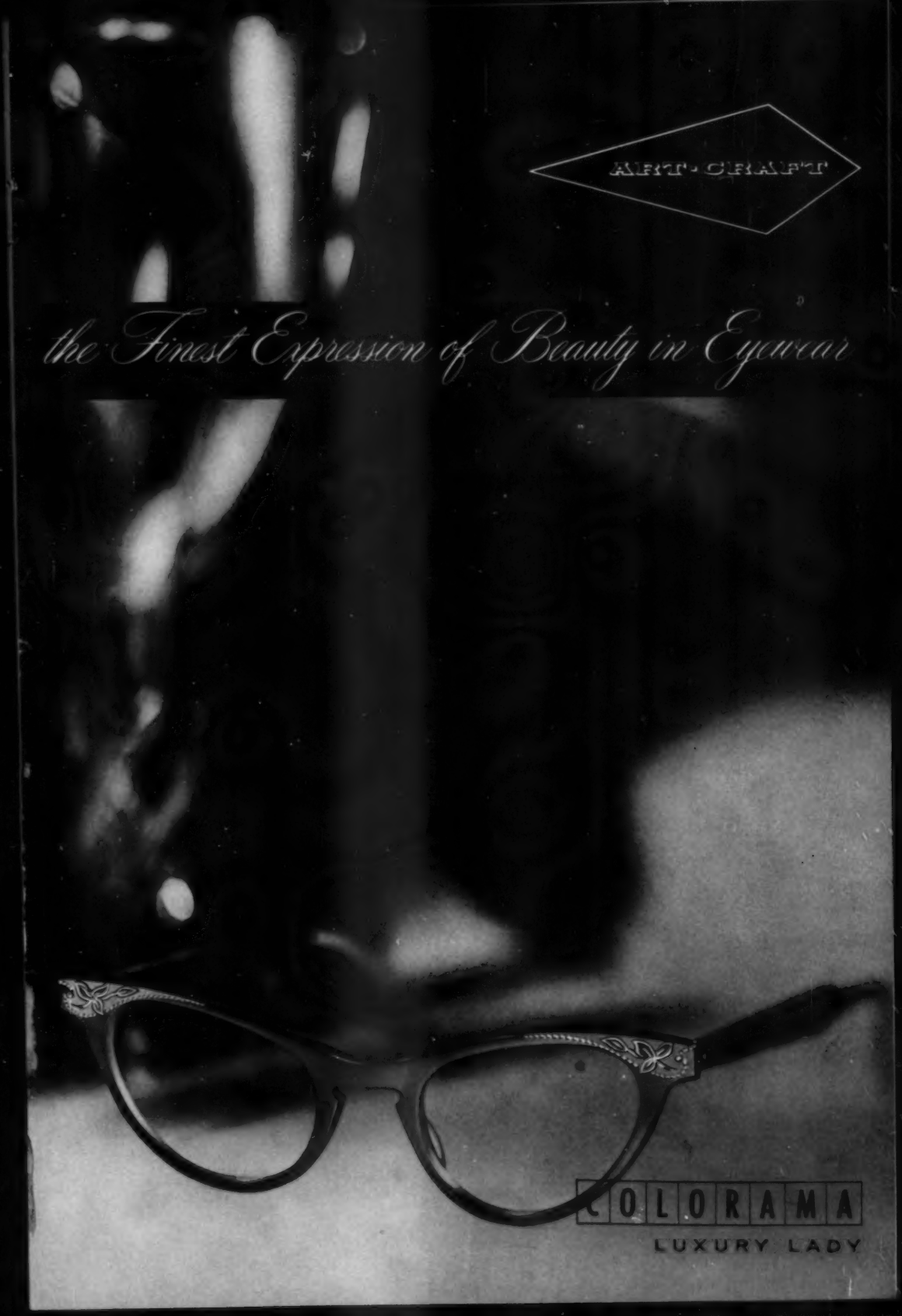
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THE DEVELOPMENT AND RETENTION OF MYOPIA BY MONKEYS*

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There is general agreement that myopia is "caused" by hereditary factors, environmental factors or, possibly, by an interaction of both. There is no agreement as to the contributions of these to the development of myopia. The agreement results from the definitions of heredity and of environment and from the somewhat arbitrary assignment of all factors or variables to one or the other of these two categories. The disagreement as to the contributions of several variables to the development of myopia follows from the inability to evaluate *experimentally* these contributions since only the experimental approach provides the control over variables which is essential to such an evaluation.[11] An experimental design which permits control over all variables is desirable, but one which permits control of either the hereditary or the environmental factor is essential. The use of identical twins in the typical "co-twin control" study holds hereditary factors constant while complete control of the environment would permit holding environmental variables constant.

With human subjects it is relatively easier to hold heredity constant through the use of one-egg twins than it is to control environmental factors. Thus a test of the effect of nearwork on the development of myopia could be achieved by having one twin engage in little or no nearwork while the other twin did a great deal of nearwork. If this situation could be replicated over a number of pairs of twins, and, if, in addition, the amount of near work done and the age at which it is done could be controlled, an adequate test of the nearwork hypothesis could be obtained. Unfortunately, this study has not been made and is not likely to be made since the obstacles encountered in obtaining enough twins and exercising the necessary degree of control over their behavior are virtually insurmountable.

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However, this is not the only adequate experimental test of the nearwork hypothesis. The converse of the co-twin study may be used: subjects of different hereditary constitutions may be exposed to the same nearwork conditions. If all subjects develop the same amount of myopia at the same rate, heredity plays no role in the development of myopia. If none of the subjects develops myopia at a rate different than that shown by a control group not exposed to the nearwork situation, then environment plays no part in the development of myopia. Finally, if the experimental subjects do not develop myopia at the same rate, but the development of myopia is significantly greater in the nearwork situation than in the control situation, there is an interaction between heredity and environment. The problems faced in pursuing this type of experimental approach with human subjects are comparable to those confronted in the co-twin approach. The availability of animals which show visual characteristics similar to man's make the second type of approach feasible because of the degree of control which may be exercised over animals.

Studies by Levinsohn and others which have been reviewed elsewhere[12] demonstrated that monkeys placed in a position such that the face was horizontal for six hours a day six days a week developed myopia ranging from one to six diopters in seventy per cent or more of the animals in less than six months. Control animals developed little or no myopia during the same period. These studies indicate that there is an interaction between hereditary and environmental factors which lead to the development of myopia. Levinsohn's studies were not designed to test the nearwork hypothesis, and the horizontal position used is not characteristic of human behavior.

METHODOLOGY

Macaca nemestrina or pigtail monkeys between three and six years of age were placed in chairs[10] which held the animal in the upright position used for sitting and sleeping. The chairs were enclosed in plywood hoods which were fitted with translucent top and front panels which prevented vision beyond 15 inches but provided four footcandles of illumination inside the hood. The experimental group consisted of nine animals, three males and six females, for the first four months under the hoods. At the end of approximately four months three animals, a sick male and two females who gave birth, were removed from the study permanently. The remaining six animals, two males and four females, were kept under the hoods for one year. Since all monkeys were removed from the hoods and chairs every two or four weeks for a two-day period and returned to the living cages, the year

group actually spent 11 months under the hoods. The control group consisted of nine animals, one male and eight females, which lived in cages in a room 8 feet wide by 16 feet long by 9 feet high.

In order to test the effects of living in the chair under the same conditions as the experimental group except for the absence of the hoods, a second control group consisting of five animals is currently being studied. The data on this group are incomplete but will be presented for comparison purposes.

The details of the refractive procedure using atropine and homatropine-paredrine cylopegics are described in detail elsewhere[12] but refractions were made biweekly using standard ophthalmic retinoscopic procedure on the experimental animals. The control animals were refracted at the beginning and at the end of an eight months period. All monkeys were refracted while in the chair with head movements prevented by means of a head holder. In order to reduce eye movements the animals were tranquilized with one and a half milligrams of Sparine per pound of body weight given intramuscularly. The effect of Sparine on refraction was determined by maintaining cyclopegia and refracting the animals before and after the administration of Sparine. It had no measurable effect. All findings were taken to the nearest quarter of a diopter. Only two animals demonstrated astigmatism and this less than 0.75 D. The refraction, therefore, was recorded as equivalent sphere.

The final test was made under the homatropine-paredrine cycloplegic as were all the other tests and also under a three day atropinization. When the refractions under the two cycloplegics were compared in 28 eyes, there were no differences in 12 eyes, 0.25 D. more plus under atropine in 15 eyes, and 0.50 D. more plus under atropine in one eye. Thus there is only one chance in 28 that the finding under homatropine-paredrine would show more than 0.25 D. more minus than the finding taken under atropine. All results presented were taken under the homatropine-paredrine cycloplegic but are similar enough to the findings taken under atropine to rule out spasm of accommodation as an explanation of the changes which have occurred.

To evaluate the permanency of the myopic changes the experimental animals were tested at different intervals of up to a year and a half after removal from the experimental situation. Changes occurring within the male and female subjects were compared.

RESULTS

The results obtained on the first control group of nine animals show an initial average refraction of 0.00 diopters and a median refrac-

TABLE 1

Equivalent-sphere refractive findings in diopters taken on 3 male (M) and 6 female (F) monkeys after indicated intervals in restricted visual space situation

Animal		Months under hoods 0	1	2	3	4	5	6	7	8	9	10	11
1 (M)	OD	−0.25	−0.75	−0.75	−1.00	−1.00	−1.25	−1.00	−1.25	−1.50	−1.75	−1.75	−1.75
	OS	−0.75	−1.00	−1.00	−1.25	−1.50	−1.50	−1.75	−2.00	−2.00	−2.00	−2.00	−2.00
9 (M)	OD	−0.25	−0.25	−0.75	−0.75	−1.00	−1.00	−1.00	−1.00	−1.00	−1.00	−1.00	−1.00
	OS	−0.50	−0.50	−0.75	−0.75	−0.75	−0.75	−0.75	−0.75	−0.75	−0.75	−0.75	−0.75
11 (M)	OD	−2.50	−2.50	−2.75	−3.00	−3.25							
	OS	−2.50	−2.75	−3.00	−3.00	−3.25							
2 (F)	OD	−0.25	−0.25	−0.50	−0.50	−0.75							
	OS	−0.25	−0.50	−0.50	−0.50	−0.50							
3 (F)	OD	−0.75	−0.75	−1.25	−1.25	−1.25							
	OS	−0.25	−0.50	−1.25	−1.25	−1.25							
7 (F)	OD	+0.25	0.00	−0.25	−0.50	−0.25	−0.75	−1.00	−0.75	−0.75	−0.75	−0.75	−0.75
	OS	0.00	−0.25	−0.25	−0.50	−0.50	−0.75	−1.00	−0.75	−0.75	−0.75	−0.75	−0.75
8 (F)	OD	−0.75	−1.00	−1.25	−1.75	−2.00	−2.00	−2.25	−2.00	−2.00	−2.00	−2.00	−2.00
	OS	−0.50	−0.75	−1.25	−1.25	−1.50	−1.50	−1.75	−1.75	−1.75	−1.75	−1.75	−1.75
10 (F)	OD	−0.50	−0.50	−0.75	−0.75	−1.00	−1.00	−1.25	−1.00	−1.00	−1.00	−1.00	−1.00
	OS	−0.25	−0.25	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50
14 (F)	OD	−0.25	−0.25	−0.50	−0.50	−0.25	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50
	OS	−0.25	−0.25	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50	−0.50

TABLE 2

Means, medians and standard deviations (SD) in diopters for the 4 month group (N=9) and the 11 month group (N=6)

Group (Measure)	Months under hoods 0	1	2	3	4	5	6	7	8	9	10	11
4 months												
Means	−0.58	−0.72	−0.99	−1.08	−1.17							
Medians	−0.35	−0.50	−0.75	−0.80	−0.96							
SDs	0.72	0.73	0.74	0.77	0.87							
11 months												
Means	−0.33	−0.48	−0.71	−0.83	−0.90	−1.00	−1.10	−1.06	−1.08	−1.10	−1.10	−1.10
Medians	−0.33	−0.34	−0.69	−0.71	−0.88	−0.88	−1.00	−0.87	−0.87	−0.87	−0.87	−0.87
SDs	0.28	0.31	0.32	0.39	0.49	0.46	0.53	0.54	0.55	0.57	0.57	0.57

tion of 0.00 diopters. The refractions at the end of eight months show an average of −0.19 D. and a median of −0.125 D. Through the use of a repeated-measures t test on the same subjects the difference between the refractive findings at the beginning and end of the eight months was found to be significant at the 5 per cent level of confidence. A comparison of the mean pretest findings on the control and experimental groups yields a difference which is also significant at the 5 per cent level on a random groups t test.

The second control which was designed to test the effects of the chair itself consists of five animals but only three of the animals have been in the chair for four months while two have been in for anly two months. The average refraction under Cyclogel, administered according to the directions for children, of the three animals at the beginning and end of the four months period are −0.54 D. and −0.58 D. respectively. For the two animals (under Cyclogel again) the corresponding values at the beginning and end of the two months period are −1.87 D. and −1.66 D. These animals have also had an initial refraction under atropine but have not been retested under atropine. The final refraction after at least six months in the chair will be made using both atropine and Cyclogel.

The refractive findings on the experimental animals are presented in Table 1 and are summarized in Table 2. The purpose of presenting the raw data of Table 1 is to illustrate the manner in which myopia develops in monkeys and the differences which may occur between the eyes of the same animal. All measures presented in Table 1 were taken at 28-32 day intervals. In order to save space the intermediate semimonthly values have been omitted. Figure 1 of the paper referred to earlier[12] indicates that this omission is not serious.

Table 2 presents the means, medians and standard deviations for both the four months period covering all nine animals and the eleven months period for the six animals which completed the study.

Table 3 contains the follow-up refractions made on the experimental and control animals which were still available after the completion of the study. The time intervals in this table represent the time elapsed between the final refraction and the follow-up refraction. These refractions were made under atropine cycloplegic. The final experimental results presented in Table 3 are not in agreement with average refraction of the control group given earlier of −0.19 diopters. This discrepancy of ⅜ of a diopter (+0.18 against −0.19) is due to the action of three variables: the differences in cycloplegics, the omission of two animals (1 male and 1 female) and the variability of the refractionist.

TABLE 3

Follow-up refractions taken on available experimental and control monkeys at indicated time intervals since final experimental and control refractions.

Animal	Eye	Final refraction (Diopters)	Time elapsed (Months)	Follow-up refraction (Diopters)
	Experimental Animals			
9 (M) *	OD	−1.00	7	−1.25
	OS	−0.75		−1.12
11 (M)	OD	−3.25	18	−4.50
	OS	−3.25		−5.12
3 (F)	OD	−1.25	18	−2.75
	OS	−1.25		−3.25
8 (F)	OD	−2.00	7	−2.50
	OS	−1.75		−2.25
10 (F)	OD	−1.00	7	−1.25
	OS	−0.50		−1.00
	Control Animals			
50 (F)	OD	+0.25	5	0.00
	OS	0.00		0.00
51 (F)	OD	−0.25	5	+0.25
	OS	−0.50		+0.25
425 (F)	OD	+0.25	5	+0.75
	OS	+0.50		+0.75
491 (F)	OD	+0.25	5	+0.25
	OS	+0.25		+0.25
493 (F)	OD	+0.25	5	0.00
	OS	0.00		+0.25
495 (F)	OD	+0.50	5	+0.38
	OS	+0.25		0.00
499 (F)	OD	+0.25	5	+0.50
	OS	+0.50		+0.50

*(M) male; (F) female

The comparison of the atropine used here and the homatropine-paredrine used earlier indicates an average refraction of 0.15 diopters more plus under atropine. The two animals which died before the follow-up refraction was taken contributed −0.08 diopters to the mean of the final refraction. Finally, since the refractionist used quarter diopter units, between the two refractions his average error would be ⅛ diopter.

Contrary to the rest of the study in which all refractions were made by the same individual, the follow-up refractions were made by a different person. In order to compare the findings made by these two refractionists seven monkeys were independently refracted under identical conditions using atropine. The results show agreement on 4 of 14 eyes, 0.25 D. difference on 7 eyes, 0.50 D. difference on 2 eyes and 0.75 D. difference on 1 eye. Taking the signs of the differences into account the mean difference is 0.11 diopter more plus for the second refractionist. Since this amount of error is within the error which must be attributed to a single refractionist, it is ignored in Table 3.

The t tests between pre-experimental refractions and the refractions at the end of four months, six months and eleven months are all significant at the 0.1 per cent level for both the nine animal and six animal groups. Thus, when the animals are used as their own controls, the changes occurring cannot be due to chance. When the experimental animals are compared with the control animals, the differences are again significant at the 0.1 per cent level. Since Table 4 indicates that males

TABLE 4

Sex differences in refraction (Diopters) among experimental animals

Measures	Four month period		Eleven month period	
	Males	Females	Males	Females
(Means)	(N = 3)	(N = 6)	(N = 2)	(N = 4)
Initial	−1.13	−0.31	−0.44	−0.28
Final	−1.79	−0.85	−1.38	−0.97
Diff.	−0.66	−0.54	−0.94	−0.69

develop more myopia under the experimental conditions than do females and there are more males in the experimental group than in the control group (3 against 1), comparisons were made between the initial refractions and the final refractions for the females alone. The results are the same as those obtained with the male animals included.

DISCUSSION

A basic assumption of this study is the comparability of the human and monkey eye with respect to the development of myopia and the conditions leading to the development of myopia. Since the monkey eye is anatomically and physiologically similar to the human eye, one might expect that human and monkey eyes would respond in the same way to the same set of conditions. A similarity of response to comparable environmental conditions should result in similar changes. The data of Table 1 indicate that monkeys confined in a nearwork situation which reasonably approximates the human nearwork situation develop myopia which is similar to that developed by humans. Three aspects of this development (a) anisometropia (b) sex differences and (c) rate of development will be compared with the results obtained on human subjects.

In a recent study of 1000 adult patients, Walton reports that anisometropia of greater than 0.50 D. in vertical meridian occurs in approximately 1 of 5 cases.[8] In Table 1 only one animal out of the six completing the study had anisometropia of 0.50 diopters although three others had differences of 0.25 diopters. The 213 myopes in the Pullman Study[13] demonstrated anisometropia of higher than 0.50 D. in 12 per cent of the children and 0.50 D. or less in 88 per cent. These

values are lower in the higher degrees of anisometropia than Walton's values but the differences may be due to the high proportion (0.57) of hypermetropes and emmetropes (0.20) in his population. The final refractions made under the experimental conditions on the monkeys gave anisometropia of 0.50 D. twelve per cent, 0.25 D. forty-four per cent and 0.00 forty-four per cent. The corresponding values for the same degrees of anisometropia on the Pullman myopes are 12 per cent, 43 per cent and 45 per cent. Thus the agreement between the myopic monkeys and human myopes in terms of degree of anisometropia is quite good although it must be interpreted with caution since the number of monkeys in our sample is so small.

The data of Tables 1 and 4 indicate that male animals show greater myopic changes than do the female animals. This result is in agreement with a number of studies on humans.[4, 6, 9] As Hirsch[4] concludes, "For myopes of less than 6.00 D. there is a greater incidence among men than among women, there being only about eight women for every ten men in this group." Again this agreement is supportive but not conclusive because of the number of animals involved.

In making comparisons between humans and monkeys with respect to the rate at which the myopic changes occur, we are limited by a lack of published data on humans which present refractions made at monthly intervals. Most of the published data available use intervals of six months or longer and either use the average yearly change or average the change over monthly intervals instead of measuring it at monthly intervals. While this approach gives an approximate rate, it does not indicate whether the changes occur at a regular or at a variable rate. No human data are available in the form of Table 1 so that close comparisons are impossible. However, if the data in Table 1 are changed to an average monthly rate by taking the difference between the initial refraction and the refraction at the end of four months and dividing the difference by four, the average rate may be compared with the average rates found on humans. The same procedure may be used for six animals over the six and eleven months periods. The average rate for the four months period ranges from —0.06 to —0.31 with a mean average rate of —0.15 D. per month. The corresponding values for the six month period are —0.04 to —0.21 with a mean average rate of —0.12 D. per month, and for the eleven months —0.02 to —0.14 with a mean average rate of —0.07 D. per month. It is obvious from Tables 1 and 2 that the major changes occur within the first six months and that the average rate of change would necessarily

decrease with further time in the situation. The same phenomenon contaminates the human data.[5]

The average monthly changes given above may be compared with values published for humans by Hofstetter.[5] For the age group 10-20 subjects ranging from 0.00 to —8.00 D. show changes ranging from 0.00 to —0.05 D. per month. While he does not present a mean average monthly change, an approximate value may be calculated from his Figure 4. This approximate value is —0.01 D. and may be compared with —0.07 D. found on the monkeys. Thus allowing for all the inaccuracies indicated above it is apparent that the mean monthly rate of change of the monkeys in the near work situation is at least as great as that found on human myopes of a comparable age; ignoring the inaccuracies, it is seven times as high.

In a series of papers Brown has presented the average yearly changes in refraction for humans. He reports a change of —0.14 diopters per year for subjects between 14 and 20 years of age[1] and values of —0.11 D. for subjects 17 - 19 and —0.05 for subjects 20 - 34 years old.[2] Slataper[7] gives values of —0.16 D. for the 17 - 19 group and —0.06 for 20 - 30 year old group. The average change for 11 months from Table 2 is —0.77 diopters. Since the monkeys are sexually mature, they should be compared to the 17 - 19 year old humans. This comparison leads to the same conclusion as drawn above.

The development of myopia as shown in Table 1 is not regular but variable in rate with changes occurring at different rates in the two eyes. It is possible that the method of measurement which arbitrarily forces the error into quarter diopter steps is responsible for the variation in rate in the same eye but this could not explain the different rates in the two eyes. Since Table 3 gives the refractive error months after removal from the experimental situation, it is possible to determine whether there is any relationship between rate of development and amount developed. This may be done by reducing the total change in the two 18 months animals to what might be expected at seven months if the rate remains constant and using a rank order correlation procedure. The rank order correlation between rate and amount at the end of seven months is 0.62 which is significant at the 0.05 level of confidence. Thus it appears that the faster the rate the greater the degree of myopia which will develop.

The data of Table 3 indicates that there is no regression once myopia has developed but rather there is likely to be continued progression even after the animals are removed from the experimental

situation. Since the animals were returned to the living cages after removal from the hoods, it is necessary to evaluate the living cage situation. The control group which lived in similar cages in the same room did not show any significant changes over a five month period following their last refraction as control animals.

Inasmuch as the chair control group did not show any myopic changes of any magnitude and the differences between the experimental and cage control groups are highly significant, the null hypothesis may be rejected. The nature of the design and the rejection of the null hypothesis permits the conclusion that restriction of visual space to what is essentially a near work situation is related to the development of myopia. Further, the data support the conclusion that the more time spent in a near work situation the greater the amount of myopia that is likely to develop since the monkeys in a continuous situation developed an average degree of myopia which is up to seven times as great as that developed by human myopes of a comparable age.

The patterns of development presented in Table 1 support an heredity-environment interaction interpretation of myopia development since not all animals responded to the situation in the same degree. The stabilization at the end of six months suggests that the eye adapts itself to the situation and remains adapted as long as the situation remains constant. The disruption of this stabilization by putting a correction on the subject would require a new adaptation to the near work situation. The amount and rate of myopia developed under this type of condition would account for most of the myopia grouped in Hirsch's[3] alpha and beta groups just as well as his hypothesized biologic variation while his formulation would have difficulty in accounting for the results presented in this study.

SUMMARY AND CONCLUSIONS

Monkeys kept in a visual space situation which is restricted to an average distance of 15 inches from the eyes over periods ranging from four months to eleven months developed degrees of myopia significantly greater than that developed by control animals not subjected to visual space restriction.

The myopia which developed is similar in degree of anisometropia and in distribution between the sexes to that developed by humans.

The rate of progression was up to seven times as rapid as that shown by humans although it leveled off at the end of approximately six months in the restricted space situation.

Since not all animals developed myopia at the same rate, heredi-

tary factors must play a role in the development of myopia.

None of the experimental animals demonstrated any regression in amount of myopia but continued to show progression when removed from the experimental situation and returned to the living cages. The control animals did not show similar changes in the same situation.

Evidence was obtained for a positive correlation between the rate of development and the amount of myopia developed.

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VARIABLES IN CORNEAL TOPOGRAPHY*

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The rapidly expanding interest in contact lenses has prompted renewed inquiry in the form of the cornea and its relationship to the sclera. A common notion of the form of the cornea is that it is spherical in curvature in any meridian: in shape, it resembles a little watch glass and just as a watch glass fits into its groove, so does the cornea fit into a groove in the sclera. The structural continuity of the cornea and sclera generally is recognized, but the almost impossible task of histological differentiation of one from the other, as a rule, is not known.[1] For these reasons, there is need for better appreciation of the variability of corneal topography and especially the zone or area of transition from the cornea to the sclera, i.e., the limbus. In this paper, types of variations will be described and specific terminology recommended for the major parameters that should be considered.

Normal Cornea. — The relationship of the normal cornea and sclera is shown in Figure 1. The sclera is circular in shape with a

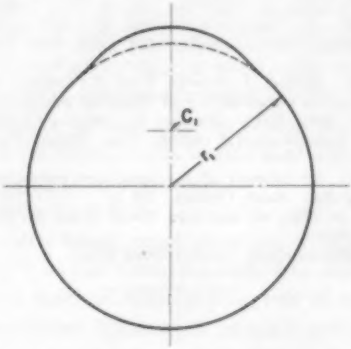

Fig. 1. Normal relationship of cornea and sclera.

radius of r_1; in the region of the cornea this curvature is indicated by the broken line. The centermost part of the cornea also is circular in

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shape with a center of curvature at C_1. The cornea is displaced from the circular contour of the sclera and this displacement is called ectasia.[2] In the normal eye the ectasia of the cornea is approximately two millimeters.

The cornea for convenience is divided into two parts: a regular central zone with the optical axis at its center and a peripheral anular zone surrounding the optic cap. The optic cap is variable in size and roughly six millimeters in diameter. Its center is slightly displaced from the geometrical center of the cornea as defined by the limbus.

The curvature of the peripheral zone of the cornea in any given meridian is variable; towards the optic cap it approximates the curvature of the cap. Towards the limbus it approaches zero curvature. This produces a peripheral flattening.

The annulus is surrounded by the limbus. From the anatomical point of view, the limbus is the zone of transition from the cornea to the sclera; optically, the limbus is a zone of negative curvature.

Constant Corneal Curvature with Variable Ectasis and Normal Limbus. — The diameter of the cornea is not constant but varies in size. This is true not only from person to person, but also in different meridians for a single eye. As a consequence an eye may have constant corneal curvature with variable ectasia and normal limbus as shown in Figure 2. The prefix constant was used for the corneal curvature merely

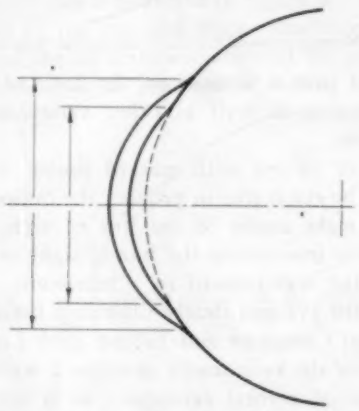

Fig. 2. Constant corneal curvature with variable ectasia and normal limbus.

to indicate the similarity of curvature regardless of the power and size of the cornea. The normal diameters of the cornea are 12 millimeters in the horizontal meridian and 11 millimeters in the vertical meridian.

These may be reduced to 10 millimeters or even less or enlarged to 14.5 millimeters in extreme cases. The probability of normal limbal curvature with either very small or large corneas is quite unlikely unless the size of the sclera varies proportionately with the cornea.

Normal Corneal Ectasia with Limbal Flattening. — Another variation in corneal topography is limbal flattening. This variation is illustrated in Figure 3 and essentially consists of an absence of a negative limbal zone and thus a limbus, on the basis of curvature. Obviously, limbal flattening as well as other variations of the cornea widely differ in degree.

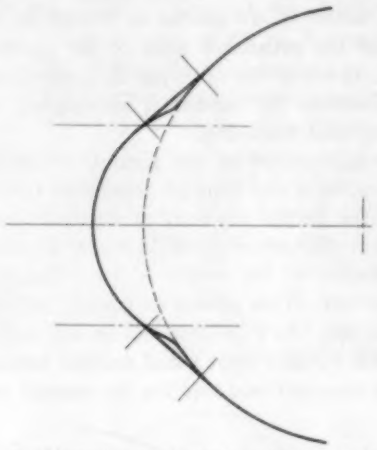

Fig. 3. Normal corneal ectasia with limbal flattening.

A photograph of an eye with marked limbal flattening is provided in Figure 4. The eye is seen in profile; the camera for the photograph was fixed at right angles to the line of sight with the optic axis of the camera lens intersecting the line of sight at the cornea. By this procedure parallax was reduced to a minimum. The view is a vertical meridian of the eye and clearly illustrates limbal flattening.

Variable Corneal Curvature and Ectasia with Limbal Flattening. —The common use of the keratometer provides a widespread appreciation of the variation of corneal curvature. It is not uncommon to encounter corneas with powers as low as 38.00 D. or as high as 48.00 D. and in exceptional cases, the powers even exceed these values.

Although there is no limit to the possible increase in corneal curvature that might be encountered, the lower limit for the most part

Fig. 4. Profile photograph of an eye with limbal flattening.

is defined by the curvature of the sclera. On this premise, the radius of curvature of the cornea would be approximately 12.2 millimeters and the keratometric power for a compensated index of 1.3375 would be 27.5 D. If the sclera of such an eye were spherical in form, the eye would have the shape of a ball with uniform curvature at all points on its surface. Also, the optical limbus would be lacking even though there were a difference on gross inspection or histological study of the two parts.

A schematic illustration of reduced corneal curvature and ectasia with limbal flattening is shown in Figure 5. Also, a photograph of an eye with these conditions is provided in Figure 6. The photograph is a horizontal section of the eye and clearly illustrates the absence of an optical limbus and the uniform curvature of the cornea and sclera. It is interesting to note that the keratometer reading of the subject for the

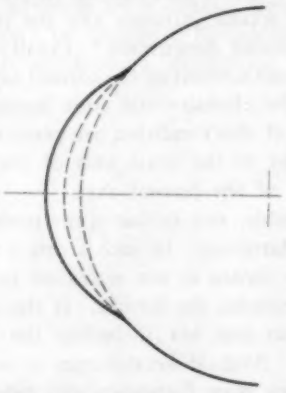

Fig. 5. Variable corneal curvature and ectasia with limbal flattening.

Fig. 6. Profile photograph of an eye with reduced corneal curvature and ectasia.

photograph was O.U. +34.00 D. sphere and the refractive correction was O.U. +11.75 ⌒ −1.50 x 90°. These findings indicate that the principal source of the refractive error was corneal in origin and that only a small difference in curvature between the cornea and sclera probably exists.

Unsymmetrical and Irregular Corneal Curvature with Variable Ectasia and Normal Limbus. — This category principally includes marked deviations in curvature and form of the corneal cap. Chief among these is keratoconus. This condition usually commences as a slight ectasia and reduction in diameter of the corneal cap; with further development, the ectasia increases and the corneal cap is reduced in size as well as displaced downward.[8] Finally, the ectasia and the reduction in size and displacement of the corneal cap are all very marked; the cornea now has the characteristic cone appearance. The steps or stages in development of this condition are presented in Figure 7. The horizontal lines parallel to the optic axis of the normal eye indicate the different positions of the corneal axes.

It is entirely possible, and in fact quite probable, for keratoconus to occur with limbal flattening. In such a case a weakness in structure and thus form of the cornea is not restricted to the corneal cap but extends to and even includes the limbus. If the cornea were weak all the way to the limbus but not including the limbus itself, limbal steepening may occur. Also, if keratoconus is asymmetrical as shown in Figure 7, the limbus may flatten on one side and steepen on the other.

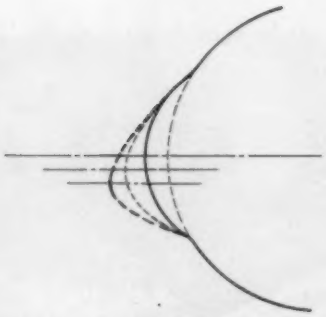

Fig. 7. Unsymmetrical and irregular corneal curvature with variable ectasia and normal limbus.

Another variation in curvature of the corneal cap is seen in Figure 8. Such a condition might result from a corneal scar or other abnormality and result in markedly unsymmetrical and irregular corneal curvature. A photograph of such a variation and diagnosed as a dermoid cyst is shown in Figure 9. This is a horizontal section of an eye.

Discussion. — The variables in corneal topography presented in this paper constitute a minimum for adequate description of the form of the cornea. If a survey of the literature is made, it quickly becomes apparent that considerable attention in the past has been given to the optical properties and thus the form of the optic cap.

However, there is a dearth of data on the form of the peripheral cornea and especially the limbus. Actually, this is not unexpected since only the optic cap is utilized for central vision. The advent, and especially the recent advances with contact lenses, makes it imperative that precise terminology be employed for variations of corneal topography. Without such terminology, description and consequently com-

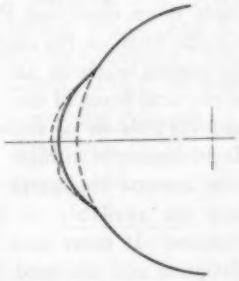

Fig. 8. Unsymmetrical corneal curvature and ectasia with normal limbus.

Fig. 9. Profile photograph of an eye with unsymmetrical and irregular corneal curvature due to a dermoid cyst. (Courtesy of Dr. B. Nuchman, Long Island, New York.)

munication about the fitting of corneal lenses becomes very difficult, if not impossible from the scientific point of view.

The recommendations in this paper also emphasize the need for accurate measurements of corneal topography as well as the more widespread use of such measurements. At present, the chief instrument for the study of corneal form is the keratometer or ophthalmometer. Such measurements, as a rule, are restricted only to the centralmost portion of the optic cap and provide little or no insight to peripheral variations. Thus a fitter is forced to make assumptions and modify the design of lenses for fitting on almost entirely empirical bases. One exception to the above procedure is the employment of the photoelectric keratoscope: this instrument is an improved Placido's disc and greatly aids in the measurement of the form of the cornea.[4, 5, 6] Its chief drawback is a restriction to the cornea without an adequate measure of the limbus. Also, data on the physical form of the cornea must be computed from optical measurements. This is a somewhat cumbersome and roundabout procedure if photographs similar to Figures 4, 6 and 9 provide the information on corneal topography directly.

At present little data are available on the form of the cornea and the frequency of variations. If more data were available, adequate screening tests could be designed and the need for modification of contact lenses to meet specific and individual needs could be evaluated.

Such data also would permit a specification of the parameters in form of the normal eye.

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A LONGITUDINAL STUDY OF REFRACTIVE STATE OF CHILDREN DURING THE FIRST SIX YEARS OF SCHOOL —A PRELIMINARY REPORT OF THE OJAI STUDY*

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In an earlier paper,[1] the Ojai longitudinal study of refraction was described. The refraction of a group of children is determined in the fall and spring of each year for 12 years (24 refractions). The study was begun in the fall of 1954 and will run until 1967. This paper is a preliminary report of 214 children for whom 12 refractive determinations have been made (over a six year period).

Although the sample size was originally 1200, many children have moved from the Ojai area. At present about 500 children are still in the sample. Testing of about a third of these was begun during the second year of the project and hence only 10 refractive tests have been done to date. Of the remainder, many have been absent on one or more test dates. The 214 children who form the basis for the present preliminary study were the only children for whom 12 determinations had been made. They are, therefore, essentially chosen at random and have not been selected on any basis other than having always been in school at the time the test was performed.

The refractive state was determined by retinoscopy while the child observed a motion picture cartoon at a 6 M. distance through a pair of +1.50 D.S. lenses. The method has been described earlier.[2] The refraction in the vertical and horizontal meridians has been determined for each eye. These four values were averaged and represent the mean refractive state for each child.

At the time of the first examination the children were between 59 and 83 months old and were in kindergarten or first grade. The fall examinations were performed in October or November of each year, the spring determinations in April or May.

The basic data for the present study, therefore, are 12 average (of the two meridians of the two eyes) refraction readings for 214 children covering a six year span.

METHOD OF ANALYSIS

The methods of statistical analysis of these data are not simple,

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nor are there any precedents to follow since there have been few longitudinal studies in the field of refraction. As a first step, the data for each child were plotted graphically and these graphs studied for general trends. Although the time between individual examinations may have been as short as four months in some instances (if the fall examination was on November 30 and the spring examination on April 1), or as long as eight months (October 1 to May 30), the assumption was made that the time between examinations was equal in all cases. In general, the examinations were scheduled to be approximately six months apart, but exceptions occurred. The assumption of equal 6 month intervals enabled us to create a mill through which all of the data could be processed.

Inspection of the graphs showed that the 12 determinations for most children appeared to be related to each other in a linear fashion. We, therefore, determined the best fitting straight line (the regression of refraction on time) for each of the 214 subjects. The least square method of line fitting was used. This yielded two values for each child, the slope of the line (change in refraction per year.) and the Y-intercept.*

Therefore, the data with which we have to work are these:

(a) A graph for each of the 214 children showing 12 points representing the average refraction at each of 12 tests six months apart. In all of these graphs the age of the child in years appears along the X-axis, the refractive state (plus = hypermetropia; minus = myopia) along the Y-axis.

(b) The slope (rate of change in refraction per year) and Y-intercept (refraction just prior to entering school) for the straight line which has the least square fit to these 12 points.

RESULTS

The 214 graphs represent the change in each child's refraction over the six year period. Although most of these seemed to be best fitted by a straight line, some were obviously curvilinear. In considering the results, it is best to begin with the various types of graphs which were observed. Each of the 214 graphs will not be presented, but a sample which illustrates each phenomenon will be presented.

*The Y-intercept is the value of Y (in this case refraction), when X (time) is zero. Thus, if we followed customary procedures, the Y-intercept would be the refraction at birth. However, since all refractive determinations were made during the child's first six years of school, such a value would be a marked extrapolation. In setting up the mill for calculations, therefore, the first examination was assigned number 1, the second, number 2, etc. The Y-intercept, therefore, is the value of refraction approximately four months before the child entered school (since the first examination was performed in October or November).

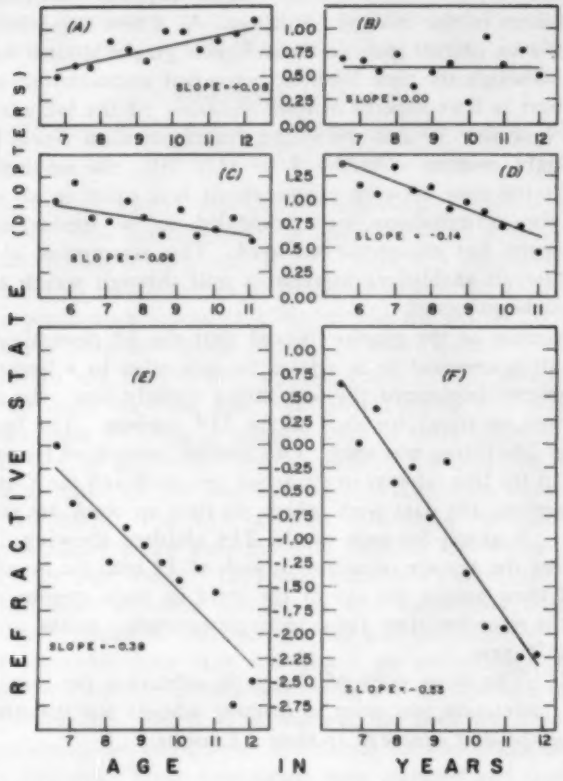

Fig. 1. Data for six subjects whose refraction varied in a linear fashion with age.

In Figure 1, there are graphs for six subjects, each having a different slope. The points are observed data, the lines mathematically fitted. For each of these, it will be noted that a straight line is as good a fit as any other line. It will be noted that for subject A there was an increase in hypermetropia of the magnitude (the slope) of 0.08 D. per year. Subject B showed no change in refraction over the entire test period, his refraction being the same at age 12 as it was at age 6½. The majority of subjects did not have graphs like these two, but some such were observed.

Subjects C and D, exhibiting linear graphs with negative slopes (decrease in hypermetropia) of moderate value, represent the majority

of the subjects. Subject C showed a slope of –0.06, i.e., a reduction of hypermetropia of 0.06 D. per year. Subject D showed a reduction of hypermetropia of 0.14 D. per year.

Subjects E and F with negative slopes of a high value are typical of those children who become myopic. Subject E is losing hypermetropia (or increasing myopia) at the rate of 0.38 D. per year, while subject F has a rate of 0.53 D. per year. Subject F, at the age of 6½ entered school with a refraction of about 0.75 D. of hypermetropia. Beginning then this child changed in a steady linear fashion toward myopia, the rate of decreasing hypermetropia and of increasing myopia being 0.53 D. per year: at the age of 12 this child has 2.25 D. of myopia

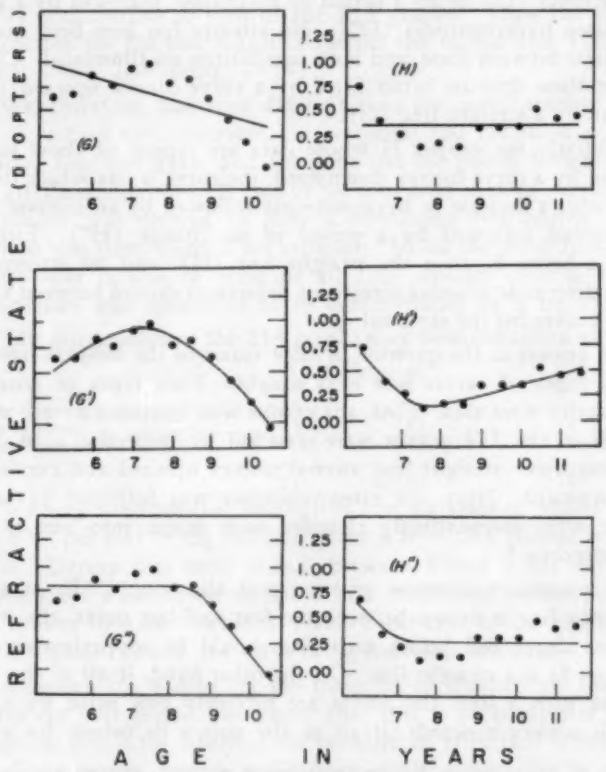

Fig. 2. Data for two subjects (G and H) whose refraction varied in a curvilinear fashion with age.

and the graph shows no sign of a change in slope as yet.

A further analysis of the slopes of these 214 children will be considered in a later paper.

The majority of the graphs were similar to those shown in Figure 1, i.e., best fitted by a straight line. However, some graphs were distinctly curvilinear. In Figure 2, subject G has a graph which is distinctly curvilinear and is best fitted by a curve which is convex upward, while the data for subject H is best fitted by a curve which is convex downward.

The curves which are convex upward may be the result of a period of increased hypermetropia followed by a period of decreased hypermetropia (G′) or by a period of no change, followed by a period of decreased hypermetropia (G″). No attempt has here been made to differentiate between these, and both possibilities are illustrated. Clearly, however, these data are better fitted by a curve convex upward (G′ or G″) than by a straight line (G).

Similarly for subject H whose data are typical of those subjects best fitted by a curve convex downward, the curve is one which demonstrates either a decrease in hypermetropia followed by an increase (H′), or a decrease followed by a period of no change (H″). Either of these is a better fit than the straight line (H), and no attempt was made to determine whether significant differences existed between various possible curves for the same subject.

An answer to the question of how many of the subjects have each of these types of curves was next sought. Two types of criteria of curvilinearity were used. First, the graphs were inspected by the author, and each of the 214 graphs were classified by inspection into one of three categories: straight line, curved convex upward and curved convex downward. Next, the same procedure was followed by another observer who independently classified each graph into one of these three categories.*

A completely objective criterion was also sought. If, in a series of points a line is drawn between the first and last point, the number of points above and below such line should be approximately equal if the best fit is a straight line. On the other hand, if all of the points lie above such a line, the points are probably best fitted by a curve which is convex upward; if all of the points lie below, by a curve

*The author expresses gratitude to Professor Frank W. Weymouth for his help. Professor Weymouth inspected each of the graphs and classified them into one of the three categories.

which is convex downward. In the present problem, however, the first point was a test conducted in the fall of the year, while the last point was a measurement made in the spring. If these two points were used, the results might be affected by seasonal variation.

To avoid any effect of seasonal variation, a line was drawn between the first and 11th points (fall, 1954, and fall, 1959) and the number of included nine determinations were counted as above or below this line. If eight of the nine points fell on the same side of the line, the probability that this was a chance occurrence was 0.02, while all nine on the same side of the line gave a P of 0.002.[a] Either of these values was considered significant. Seven points on the same side had a P of 0.09 and this was regarded as not significant. This test for curvilinearity was applied to each of the 214 graphs. Then the same test was repeated for the line which connected the second and 12th points (spring, 1954, and spring, 1959).

We, therefore, had four different tests for curvilinearity: inspection by each of two observers, the statistical test for those points between the first and 11th, and the same test for points between second and 12th determinations. If two of the four tests showed curvilinearity, that subject was deemed to have a curvilinear relationship between refraction and time, using a lax criterion. If, on the other hand, curvilinearity was present in three or all four separate criteria, then the curvilinearity was considered to be demonstrated by a rigid criterion.

The distribution of the 214 graphs may be summarized as follows:

	Rigid Criterion		Lax Criterion	
	N	%	N	%
Straight Line	193	(90)	179	(84)
Convex Upward	13	(6)	18	(8)
Convex Downward	8	(4)	17	(8)
	214	(100)	214	(100)

We may conclude that during the first six years of school between 84 and 90 per cent of the children show a refraction change in a linear fashion. During this same period, between 6 and 8 per cent of the children show a refraction variation in a curvilinear fashion, the curve being convex upward; between 4 and 8 per cent of the children vary in a curvilinear fashion, the curve being convex downward.

Although the graphs for the majority of children are linear during this six year period, we know that this is probably not the case throughout life. One aspect of the problem of refraction which inspection of the graphs in this preliminary study emphasizes is the need for data during as many of the years prior to school as possible. Such

a study of children between the ages of three and six is needed. We also know (Morgan[4]) that the refraction of many individuals changes little during the twenty year period which begins at an age slightly older than the oldest age of the children in the present sample.

The present study is preliminary. Data on these children for an additional six years will ultimately become available. The amount of theorizing which should be done at this stage of the data collecting must therefore be limited. In a subsequent paper we shall give data for the slopes of the lines for those children whose data are best fitted by a straight line. The 35 subjects whose data are (by lax criteria) fitted by a curvilinear pattern will not be included in such a study, and we may at this time consider a few related data for these subjects.

For each of these 35 subjects, the refraction at the time the child entered school may be approximated from the Y-intercept. Also, the sex of each child was known. We have, therefore, three variables which may be related: (a) Type of curve (i.e., convex upward or convex downward), (b) Boy or girl, and (c) Approximate degree of hypermetropia upon entering school.

The three fourfold tables necessary to test (by Chi square) these possible relationships were constructed, and in each instance a relationship significant to at least the 0.05 per cent level of probability was found.

The convex downward curve tended to be found among boys, the convex upward among girls ($P = 0.001$). The boys tended to have less hypermetropia, the girls more (P between 0.02 and 0.05). Those children with a curve which was convex upward tended to be the children with greater hypermetropia; those convex downward, less (P between 0.02 and 0.05). Thus, there seems to be a relationship between boys, convex downward curve and less hypermetropia, and between girls, convex upward curve and more hypermetropia.

It is stressed that these relationships were determined only for the 35 children who exhibited a curvilinear pattern for refractive change, and only for the age range studied. A further analysis of the 84 per cent of the children whose refraction changed in a linear fashion will be presented in a subsequent paper.

The author is indebted to Professors Weymouth, Stoddard, Morgan and Flom of the University of California School of Optometry staff for reviewing these data and for many valuable suggestions. For statistical clerical work, the author thanks Geoffrey A. Hirsch.

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TRANSMITTANCE OF THE VISIBLE SPECTRUM THROUGH THE COMPONENTS OF THE BOVINE OCULAR MEDIA*

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INTRODUCTION

Data from the studies on the transmittance of the ocular media[2, 9, 12, 15, 16, 18, 21, 22] have been used by several authors to help establish certain fundamental and theoretical concepts in physiological optics. Troland[20] used such data to calculate the photopic visibility function. Ludvigh[14] used his own 50 percent transmittance for the human eye to calculate the scotopic visibility curve. Hecht, et al.[10] used Ludvigh's data of 50% transmittance at 545 mμ to establish the number of rods and cones necessary to be stimulated by one quantum of energy to initiate a visual stimulus. Fry[7] re-evaluated the scattering theory of glare by the use of ocular transmittance data of Ludvigh and McCarthy.[14] More recently, Ham, et al.[8] established the transmittance of the rabbit eye and used this transmittance in determining the threshold for chorioretinal burns.

Transmission data could be used as a correction factor in the determination of the true retinal illuminance. The C. I. E. (Commission Internationale de l'Eclairage) trichromatic coefficients of the human eye have been calculated and used to determine the dominant wavelength and "spectral purity" of the human eye.[15] A review and summary of the literature concerning transmittance studies has been reported in a previous paper.[17]

These fundamental and theoretical concepts and the advent of nuclear energy have made it necessary to establish more accurately the true transmittance of the visible spectrum through the ocular media. A study of the transmittance of the components of the eye might prove helpful in many phases of experimental physiological optics. This paper is a report on the measurements of the transmittance of the components for the bovine eye.

APPARATUS AND PROCEDURE

The basic instrument used in this study was a Beckman Model B

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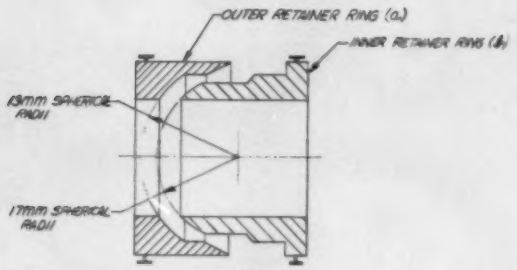

Fig. 1. Cross section of cornea and lens holder: a, outer portion: b, inner portion: r, 19 mm.: N_2, 17 mm.

Spectrophotometer.[23] Details concerning the instrument sensitivity, laboratory controls, alignment procedures, and general procedures was given in a report on the transmittance of the intact bovine eye.[17] The procedure for each of the eye media—i. e., the cornea, the aqueous, the lens, and the vitreous—was perfected on five eyes. Each transmission reading was taken on a different eye. Therefore, five individual eyes were required to obtain the data given in one table. Because this method was required to obtain the data, the mean deviation was selected as a measure of variability. The decimals in the measurements were dropped if under 0.5 percent and, if above, were recorded as 0.5 percent.

Figure 1 shows the holder for the lens and the cornea. This holder consisted of two machined aluminum tubes with a common central opening 2.54 centimeters in diameter. The outside tube slipped over the inner tube and was held in place by rubber bands. The end of the inner tube was machined to a radius of 17 mm., the radius of the inside of the average bovine eye. The corresponding contact surface, inside of the outer tube, was machined to a 19 mm. radius.

The lens and cornea techniques are so similar that their procedures will be discussed simultaneously. The cornea was mounted by removing the posterior half of the sclera. The iris, lens, and vitreous were carefully removed next and the cornea bathed in normal saline solution to remove any possible traces of pigment. The scleral shell was slipped over the inner portion of the holder (Figure 1b). The outside portion of the holder (Figure 1a) was then placed over the specimen and kept in place by rubber bands. In preparing the lens, the sclera, posterior to the equator, and the vitreous body were carefully removed. The specimen was next placed over the inner portion of the holder and the iris and cornea carefully excised. The outside portion of the lens holder was then placed over the sclera supporting

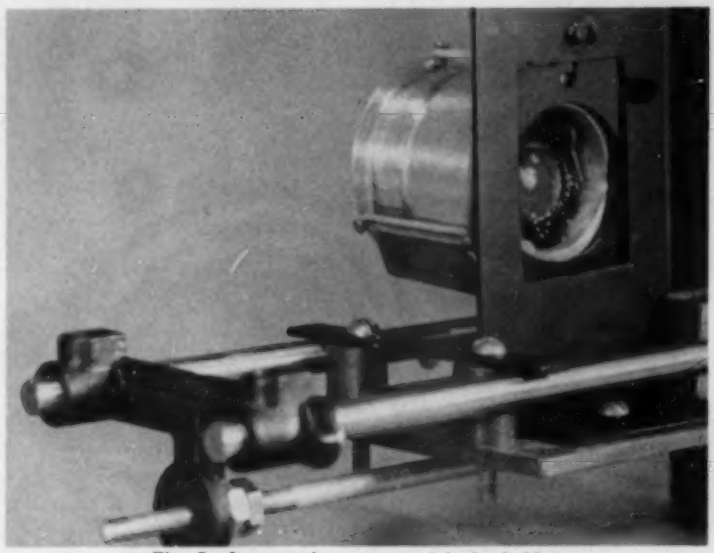

Fig. 2. Lens specimen mounted in its holder.

the lens specimen and clamped into place (Figure 2). The mounted specimen was carefully aligned and the transmission readings taken. The lens holder was moved close enough to the photocell to keep the area of the standard and the transmitted light falling on the phototube equal.

The aqueous was extracted from the anterior chamber by use of a 20 gauge hypodermic needle and sterile syringe. The needle was inserted through the cornea at the corneoscleral junction and the aqueous slowly withdrawn. The aqueous was deposited into one of the Beckman standard pyrex cells. The standard cells have an inside cross-sectional measurement of 1 square centimeter. The cells used showed less than one percent difference in transmittance. Two bovine eyes provided enough aqueous to fill each cell. The cell was placed in the cell holder and transmission readings taken.

The intact eye holder of the previous study[17] was used to obtain the vitreous body data. A 1½ cm. square surgical opening was made through the sclera at the approximate position of the posterior pole. The eye was then inverted and placed with this opening on a large glass plate. The sclera was incised just posterior to the corneoscleral junction and the iris. lens. and cornea carefully separated from the

TABLE I
RELATIVE TRANSMISSION OF THE CORNEA
Transmission Raw Data

Wavelength $m\mu$	T_1	T_2	T_3	T_4	T_5	Mean T_{mc}	Mean Deviation
370	64.0	62.0	65.0	66.0	65.0	64.0	1.2
380	69.0	67.0	72.0	71.0	71.0	70.0	2.0
390	72.0	71.0	74.0	75.0	76.0	73.6	2.2
400	74.0	73.0	79.0	77.0	79.0	76.4	2.3
410	75.0	74.0	81.0	78.0	79.5	77.5	3.2
420	76.0	75.0	82.0	78.5	80.5	78.4	2.7
430	78.0	77.0	83.0	80.0	82.0	80.0	2.5
440	80.0	79.5	85.0	82.0	83.5	82.0	1.8
450	81.0	80.0	86.0	83.0	85.0	83.0	2.0
460	82.0	81.0	87.0	84.0	85.0	83.8	1.8
470	83.0	82.0	88.0	85.0	86.0	84.8	1.8
480	84.0	82.5	88.5	86.0	87.0	85.6	1.3
490	84.0	83.0	89.0	87.0	87.0	86.0	2.0
500	85.0	84.0	89.0	87.0	88.0	86.6	1.9
510	86.0	84.0	89.5	88.0	88.0	87.1	1.6
520	86.5	84.5	90.0	88.0	88.0	87.4	1.5
530	87.0	85.0	90.0	88.0	89.0	87.8	1.6
540	87.5	85.0	90.0	89.0	90.0	88.3	1.6
550	88.0	85.5	91.0	89.0	90.0	88.7	1.5
560	88.0	86.0	91.0	89.0	90.0	88.8	1.4
570	88.5	86.5	91.0	90.0	90.0	89.2	1.3
580	88.5	87.0	91.0	90.0	90.0	89.3	1.2
590	89.0	87.0	91.0	90.0	90.5	89.5	1.2
600	89.0	87.0	91.0	91.0	91.0	89.8	1.0
610	89.0	87.0	92.0	91.0	91.0	90.0	2.0
620	89.5	87.5	92.0	91.0	91.0	90.2	1.3
630	90.0	88.0	92.0	91.0	91.0	90.4	0.9
640	90.0	88.0	92.0	91.0	91.5	90.5	1.0
650	90.0	88.0	92.0	91.0	92.0	90.6	1.0
660	90.0	88.0	92.0	91.0	92.0	90.6	1.0
670	90.0	88.0	92.0	91.0	92.0	90.6	1.0
680	90.0	88.0	92.0	91.5	92.0	90.7	1.1
690	90.0	88.0	92.0	92.0	92.0	90.8	1.1
700	90.0	88.0	92.0	92.0	92.0	90.8	1.1

vitreous body. This procedure left the vitreous intact and enclosed within the scleral shell. Thin glass plates were carefully placed against the vitreous at the anterior and posterior openings of the scleral shell. The vitreous specimen was mounted in the eyeholder, properly aligned, and transmission readings taken.

RESULTS

The data for the relative transmission of the cornea, aqueous, lens, and vitreous are shown in Tables I through V. In these tables the raw data (T_1, T_2, etc.), mean raw data (T_m), and corrected mean data (T_c) are listed in their respective columns opposite the appropriate wavelength in millimicrons. The mean raw data designation (T_m) and the mean corrected designation (T_c) in each table contain an addi-

TABLE II
RELATIVE TRANSMISSION OF 10.0 mm. AQUEOUS
Transmission Raw Data*

Wavelength $m\mu$	T_1	T_2	T_3	T_4	T_m	Mean T_{ma}**
370	85.0	85.0	82.0	86.0	84.5	88.1
380	85.5	86.0	82.0	86.0	84.8	88.4
390	86.5	87.0	83.5	86.5	85.8	89.2
400	87.0	87.5	84.0	87.0	86.4	89.6
410	87.0	87.5	85.0	87.5	86.4	89.8
420	87.0	88.0	85.5	87.0	86.8	89.9
430	87.0	88.0	86.0	87.0	87.0	90.1
440	87.5	88.0	86.0	87.5	87.2	90.2
450	87.5	88.0	86.0	88.0	87.3	90.3
460	88.0	89.0	86.0	88.5	87.8	90.7
470	88.0	88.5	86.5	86.5	88.0	90.8
480	88.0	88.5	86.5	89.0	88.0	90.9
490	88.0	89.0	87.0	89.5	88.4	91.1
500	88.5	89.0	87.0	89.5	88.5	91.2
510	89.0	89.5	87.0	89.5	88.6	91.3
520	89.0	89.5	87.0	89.5	88.6	91.3
530	89.0	89.5	87.0	90.0	88.8	91.5
540	89.0	89.5	87.0	90.0	88.8	91.5
550	89.0	89.5	87.0	90.0	88.8	91.5
560	89.0	89.5	87.5	90.0	89.0	91.6
570	90.0	90.0	88.0	90.0	89.5	92.0
580	90.0	90.0	88.0	90.5	89.6	92.1
590	90.0	90.0	88.0	90.5	89.6	92.1
600	90.0	90.0	88.0	90.5	89.6	92.1
610	90.5	90.0	88.0	90.5	89.7	92.2
620	90.5	90.0	88.0	90.5	89.7	92.2
630	90.5	90.0	88.0	90.5	89.7	92.2
640	90.5	90.0	88.0	90.5	89.7	92.2
650	91.0	90.0	88.0	90.5	89.9	92.3
660	91.0	90.0	88.0	90.5	89.9	92.3
670	91.0	90.0	88.0	90.0	89.7	92.2
680	91.5	90.0	88.0	90.5	90.0	92.4
690	91.5	90.0	88.0	90.0	89.9	92.3
700	91.0	89.0	88.0	90.0	89.5	92.0

*10.0 mm. aqueous
**7.5 mm. aqueous

tional subletter to indicate the eye component represented: c for the cornea, a for the aqueous, l for the lens, and v for the vitreous. Table VI presents the bovine eye constants used for calculations in this study. The graphs are plotted from the mean corrected data with the wavelength in millimicrons as the abscissa and the relative transmittance as the ordinate.

Table I gives the transmission of the visible spectrum through the cornea of the bovine eye relative to air. No corrective factors were necessary for the relative transmission because air was used as a standard. Column T_{mc} presents the mean transmittance. The mean deviation of the raw data has also been computed.

TABLE III
RELATIVE TRANSMISSION OF 20. mm. VITREOUS
Transmission Raw Data

Wavelength $m\mu$	T_1	T_2	T_3	T_4	Mean T_{mv}
370	82.5	81.0	81.5	82.0	81.7
380	83.0	81.5	83.0	83.0	82.6
390	84.0	82.0	84.0	84.0	83.5
400	84.5	83.0	84.0	84.5	84.0
410	85.0	83.0	84.5	85.0	84.4
420	85.0	84.0	85.0	85.5	84.9
430	86.0	84.5	85.5	86.0	85.5
440	86.0	85.5	86.0	86.5	86.0
450	86.5	86.0	86.5	87.0	86.5
460	87.0	86.5	87.0	87.0	86.8
470	87.5	87.0	87.0	87.5	87.3
480	87.5	87.5	87.5	88.0	87.6
490	88.0	88.0	88.0	88.0	88.0
500	88.0	88.0	88.0	88.0	88.0
510	88.5	88.0	88.0	88.0	88.1
520	88.5	88.0	88.0	88.5	88.2
530	89.0	88.5	88.0	88.5	88.5
540	89.0	88.5	88.0	88.5	88.6
550	89.0	89.0	88.5	88.5	88.8
560	89.0	89.0	89.0	89.0	89.0
570	89.0	89.0	89.0	89.0	89.0
580	89.0	89.0	89.0	89.0	89.0
590	89.0	89.0	89.0	89.0	89.0
600	88.5	89.0	89.0	89.0	88.9
610	88.5	88.5	88.5	89.0	88.7
620	88.5	88.5	88.5	88.5	88.5
630	88.5	88.5	88.5	88.5	88.5
640	88.5	88.5	88.5	88.5	88.5
650	88.5	88.5	88.5	88.5	88.5
660	88.0	88.0	88.0	88.5	88.1
670	88.0	88.0	88.0	88.5	88.1
680	88.0	88.0	88.0	88.0	88.0
690	88.0	88.0	88.0	88.0	88.0
700	88.0	87.0	88.0	87.5	87.6

The raw transmission data of the visible spectrum through 10.0 mm. thickness of bovine aqueous is given in Table II. Laurens[13] reports the depth of the anterior chamber as 7.5 mm. To calculate the transmittance of 7.5 mm. of aqueous from the 10.0 mm. experimental data, the following formula was used:

$$\text{Log } T_2 = \frac{t_2}{t_1} \text{ Log } T_1$$

T_2 is the transmittance of 7.5 mm. of aqueous and T_1 of 10.0 mm. of aqueous; t_2 equals 7.5 mm. and t_1, 10.0 mm. The results of these calculations are shown under column T_{mv}, Table II.

The index of refraction of the pyrex cell was taken as 1.480 for

TABLE IV
ABSOLUTE AND RELATIVE TRANSMISSION OF AQUEOUS AND VITREOUS

Wave-length	Aqueous (7.5 mm.)			Vitreous (20.0 mm.)		
			Mean			Mean
$m\mu$	T_a*	T_{ca}	Deviation**	T_v*	T_{cv}	Deviation**
370	90.9	95.0	1.2	85.7	89.8	0.5
380	91.2	95.3	1.4	86.6	90.7	0.6
390	92.0	96.1	1.2	87.6	91.7	0.7
400	92.4	96.5	1.1	88.2	92.3	0.5
410	92.6	96.7	0.9	88.6	92.7	0.7
420	92.7	96.8	0.7	89.2	93.3	0.4
430	92.9	97.0	0.5	89.8	93.9	0.5
440	93.0	97.1	0.6	90.4	94.5	0.3
450	93.1	97.2	0.7	90.9	95.0	0.3
460	93.5	97.6	0.9	91.1	95.3	0.2
470	93.6	97.7	0.8	91.8	95.9	0.2
480	93.7	97.8	0.8	92.2	96.3	0.2
490	93.9	98.0	0.7	92.5	96.6	0.0
500	94.0	98.1	0.7	92.5	96.6	0.0
510	94.1	98.2	1.2	92.7	96.8	0.2
520	94.1	98.2	0.9	92.8	96.9	0.3
530	94.3	98.4	0.9	93.1	97.2	0.3
540	94.3	98.4	0.9	93.2	97.3	0.3
550	94.3	98.4	0.9	93.4	97.5	0.2
560	94.4	98.5	0.9	93.7	97.8	0.0
570	94.5	98.9	0.7	93.7	97.8	0.0
580	94.9	99.0	0.8	93.7	97.8	0.0
590	94.9	99.0	0.8	93.7	97.8	0.0
600	94.9	99.0	0.8	93.5	97.6	0.6
610	95.0	99.1	0.9	93.3	97.4	0.3
620	95.0	99.1	0.9	93.1	97.2	0.0
630	95.0	99.1	0.9	93.1	97.2	0.0
640	95.0	99.1	0.9	93.1	97.2	0.0
650	95.1	99.2	0.9	93.1	97.2	0.0
660	95.1	99.2	0.9	92.7	96.8	0.1
670	95.1	99.2	0.9	92.7	96.8	0.1
680	95.2	99.3	0.7	92.5	96.6	0.0
690	95.1	99.2	0.9	92.5	96.6	0.0
700	94.8	98.9	1.0	92.2	96.3	0.2

* Represents the relative transmission
**Represents the mean deviation of the raw data

sodium light and the index of refraction of the vitreous as 1.336. The formula:

$$\frac{I}{I_o} = \frac{(n_2 - n_1)^2}{(n_2 + n_1)^2}$$

gives the reflection loss at the air to glass surface equal to 3.2 percent and the reflection loss at the glass to aqueous surface equal to 0.2 percent. Column T_{ca}, Table IV, represents the absolute transmittance of 7.5 mm. aqueous after correction for reflection losses have been made.

The relative transmission data for a 20.0 mm. thickness of vitreous

TABLE V
RELATIVE TRANSMISSION OF THE LENS

Wavelength $m\mu$	T_1	T_2	T_3	T_4	Mean T_{ml}	Mean Deviation
370	32.0	35.0	36.0	32.0	33.7	1.7
380	46.0	47.0	48.0	47.0	47.2	0.6
390	59.0	61.0	61.0	61.0	61.0	0.7
400	67.0	68.0	68.0	68.0	67.7	0.4
410	70.0	73.0	72.0	73.0	72.0	1.0
420	73.0	75.0	76.0	76.0	75.0	1.0
430	75.0	77.0	77.0	78.0	76.7	0.9
440	78.0	79.0	79.0	80.0	79.0	0.5
450	79.5	81.0	81.0	82.0	80.8	0.7
460	81.0	82.0	83.0	84.0	82.5	1.0
470	82.0	83.0	85.0	85.0	83.2	1.2
480	83.0	85.0	86.0	86.0	85.0	1.0
490	84.0	86.0	86.5	87.0	85.8	0.9
500	85.0	86.0	87.0	88.0	86.5	1.0
510	86.0	87.0	88.0	89.0	87.5	1.0
520	86.5	87.5	89.0	89.0	88.0	1.0
530	87.0	88.0	89.0	89.5	88.3	0.8
540	87.0	88.0	89.5	90.0	88.6	0.8
550	88.0	89.0	89.5	90.0	89.1	0.6
560	88.5	89.0	89.0	90.5	89.2	0.6
570	89.0	89.0	90.0	91.0	89.7	0.7
580	89.0	89.5	90.0	91.0	89.8	0.5
590	89.0	90.0	91.0	91.5	90.3	0.8
600	89.0	90.0	91.0	92.0	90.5	0.8
610	89.5	90.0	91.5	92.0	90.7	1.0
620	90.0	90.5	91.5	92.5	91.1	0.8
630	90.0	90.5	92.0	93.0	91.3	1.1
640	90.0	91.0	92.0	93.0	91.5	1.0
650	90.0	91.0	92.0	91.5	91.5	1.0
660	90.0	91.0	92.0	93.0	91.5	1.0
670	90.0	91.0	92.0	93.0	91.5	1.0
680	90.0	91.0	92.5	93.0	91.6	1.1
690	90.0	91.0	92.5	93.0	91.6	1.1
700	90.5	91.0	92.5	93.0	91.7	1.0

is given in Table III. Corrections were calculated for losses due to reflection as described in a previous paper.[17] The total loss by reflection for both glass plates was found to be 9.2 percent. The transmittance of the vitreous was computed by combining the reflection losses with column T_{mv}, Table III. The resulting figures are shown in column T_{cv} of Table IV.

The transmission of the bovine lens relative to air is given in Table V. A preliminary study was made to determine the effects of postmortem time on transmission when the lens was suspended in air. We expected the lens to lose its transmission characteristics quite rapidly. However, no appreciable losses at 550 $m\mu$ were found over a 2 hour period. The total time to complete a single lens was less than 20 minutes and only two lenses were taken in a session. Therefore, it was

TABLE VI
BOVINE EYE CONSTANTS

Cornea*:	
Horizontal	29.0 mm.
Vertical	24.0 mm.
Globe*:	
Transverse	43.0 mm.
Vertical	42.0 mm.
Anteroposterior	37.0 mm.
Depth of Anterior Chamber**	7.5 mm.
Depth of Vitreous**	22.5 mm.
Depth of Lens**	7.0 mm.
Indices of Refraction†:	
Aqueous	1.336
Vitreous	1.336
Lens	1.392
Cornea	1.377

* Taken from Henderson (ref. 11)
**Taken from Laurens (ref. 13)
† Taken from Duke-Elder (ref. 6)

felt that suspending the lens in air had no effects on the transmission readings. Column T_{ml} presents the mean lens transmittance relative to air.

To compute the total transmittance of the eye from its components, a correction for loss due to reflection must be made for the cornea and lens data. Computations for loss at the posterior cornea to air surface shows 2.5 percent for a corneal refractive index of 1.377. Lens computation reveals a loss of 5.4 percent for both surfaces when the lens refractive index is taken as 1.392.

The aqueous and vitreous data must be in relative transmittance to be compared with the relative transmittance of the cornea and lens. It is necessary to subtract the losses due to the air to aqueous surfaces (2.06 percent) from the absolute value to obtain the transmittance of 7.5 mm. aqueous relative to air. T_a, Table IV, gives the transmittance of 7.5 mm. of aqueous relative to air and column 4 shows the mean deviation of the raw data. To calculate the relative transmittance for the vitreous, compute the reflection losses at the air to vitreous surfaces (2.06 percent) and deduct it from the absolute value. The transmittance of vitreous relative to air is shown in Table IV, column T_v. The mean deviation of these figures are also shown in the table.

DISCUSSION

An examination of the data for the media of the bovine eye reveals some interesting relationships. The lens with 89.1 percent*

*The transmittance percentages presented here are for the respective wavelengths but may increase or decrease at other wavelengths.

and the cornea with 88.7 percent absorb the most or transmits the least amount of the visible spectrum. The aqueous transmittance of 98.4 percent and the vitreous transmittance of 97.5 percent reveal that only a small portion of the visible spectrum is absorbed. Shoji[19] reports that the lens has the greatest absorption, next the cornea, then the vitreous and least the aqueous. Kinsey[12] found the same arrangement in the order of absorption of ultraviolet radiation. The bovine component data presents the same general trend.

Kinsey's graph and data extend to 500 mμ and can be partially compared to this study. Table VII presents the calculations of the bovine ocular media transmittance and those of Kinsey's rabbit media. Figure 3, plotted from Table VII, demonstrates a remarkable likeness

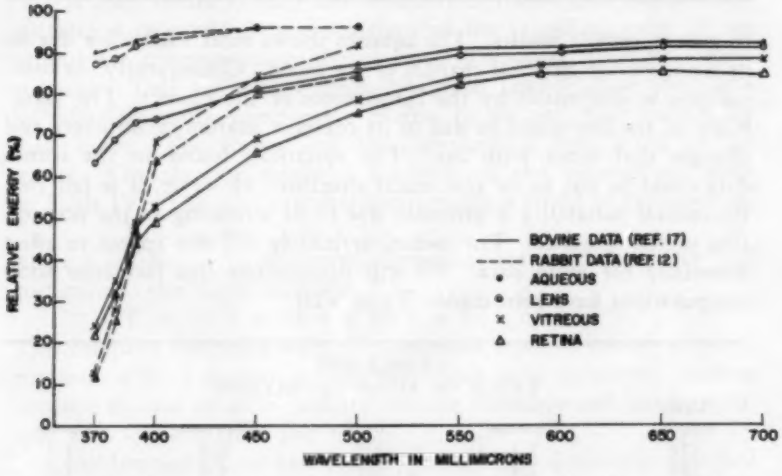

Fig. 3. Percent of energy incident on the anterior surfaces of the ocular media components. Plotted from Table VII.

to the two sets of data. The differences are probably due to the pathway length the light must traverse before striking the retina, i.e., the globe size. The bovine data supports the suggestion of Kinsey that, with so little abiotic ultraviolet reaching the retina, damage from these rays would be almost impossible or, at least, extremely remote.

The variability of the data is shown by the mean deviations given in Tables I, IV and V. The vitreous shows the least variability and is followed in order by the aqueous, the lens, and the cornea. The order could be anticipated from the various characteristics of the different media. The vitreous is a relatively stable tissue and would be expected

TABLE VII
CALCULATED PERCENTAGE OF ENERGY INCIDENT ON THE ANTERIOR SURFACES OF THE OCULAR MEDIA COMPONENTS

Wavelength	Bovine Data (17)				Rabbit Data (12)			
	AQ	Lens	Vit.	Ret.	AQ	Lens	Vit.	Ret.
370	66.5	63.1	24.4	21.9	90.0	87.0	12.1	11.0
380	72.5	69.0	35.3	32.0	91.2	88.2	28.2	25.8
390	76.1	73.1	48.2	44.2	92.8	91.4	48.5	44.6
400	76.5	73.8	53.1	49.0	94.0	93.0	68.5	63.5
450	83.5	81.1	69.6	66.0	96.0	96.0	84.0	80.5
500	87.5	85.8	78.5	75.8	96.0	96.0	86.5	84.0
550	91.2	89.7	84.7	82.6	—	—	—	—
600	91.5	90.5	87.3	85.2	—	—	—	—
650	92.5	91.7	88.5	85.9	—	—	—	—
700	92.5	91.5	88.4	85.0	—	—	—	—

to give repeatable results. The aqueous shows more variability due to its sensitivity to chemical changes of the blood. Consequently, its composition is determined by the constituents of the blood.[1] The variability of the lens could be due to its complex anatomical structure and changes that occur with age. The variations found in the cornea data could be due to its anatomical structure. However, it is felt that the corneal variability is probably due to its wrinkling in the preparation of the specimen. The corneal wrinkling did not appear to affect materially the mean data. We will demonstrate this fact after some computations have been made. Table VIII.

TABLE VIII
TABLE OF MEAN DEVIATIONS

Wavelength	Aqueous	Lens	Vitreous	Cornea
370	1.2	1.7	0.5	1.2
380	1.4	0.6	0.6	2.0
400	1.1	0.4	0.5	2.3
420	0.7	1.0	0.4	2.7
440	0.6	0.5	0.3	1.8
460	0.9	1.0	0.2	1.8
480	0.8	1.0	0.2	1.3
500	0.7	1.0	0.0	1.9
520	0.9	1.0	0.2	1.5
540	0.9	0.8	0.3	1.6
560	0.9	0.6	0.0	1.4
580	0.8	0.5	0.0	1.2
600	0.8	0.8	0.6	1.0
620	0.9	0.8	0.0	1.3
640	0.9	1.0	0.0	1.0
660	0.9	1.0	0.1	1.0
680	0.7	1.1	0.0	1.1
700	1.0	1.0	0.2	1.1

The experimental procedure for the transmission through the aqueous and the vitreous could be objectionable since these media present curved optical surfaces in the eye and the procedure reduced them to flat optical surfaces. Several methods were studied for the aqueous but the pyrex cells provided the most convenient method and the necessary correction data for calculations. The objection would be alleviated in the vitreous data because the adopted procedure provided minimum vitreous disturbance. It was felt that the least disturbance to the vitreous cellular structure offered a more nearly ideal method and was more important than the curvature loss. No losses of the vitreous body occurred during the experimentation because it readily adhered to the glass surfaces.

A check on the validity and reliability of the eye component transmittance data would be a comparison of the calculated value of the various eye components to the previously reported intact eye transmittance. This calculation must take into consideration the losses by reflection of the components relative to air and must correct for these losses. The cornea and lens calculations were given in the results. The absolute values of the aqueous and vitreous are given in Table IV. The total calculated transmittance could be expressed as:

$$T = t_c \times t_a \times t_l \times t_v$$

where t represents the respective component transmittance. For 550 millimicrons this value would be:

$$T = 91.2 \times 98.4 \times 94.5 \times 97.5 \text{ or } 82.6\%$$

This compares favorably with the previously reported intact eye transmittance of 84.3 percent at 550 mμ. Such close agreement in these two sets of data seems to indicate that the technique and instrumentation were quite reliable and valid.

DeMott and Davis[3] have recently presented total transmittance data for excised steer eye. The upper curve of Figure 4 presents a comparison for the total transmittance of my previous study[17] and the calculated component transmittance of this study with the total transmittance of DeMott and Davis. Each study utilized a large aperture and is estimated to include almost all the scattered light, along with the directly transmitted light.* Excellent agreement is obtained for the total eye transmittance. However, the calculated transmittance from the media values shows slightly less transmittance. It is felt that the decrease in the calculated transmittance is due to the additional backscattering of

*DeMott and Davis estimate 90.0 percent of the scattered light is included in their transmittance measurements.

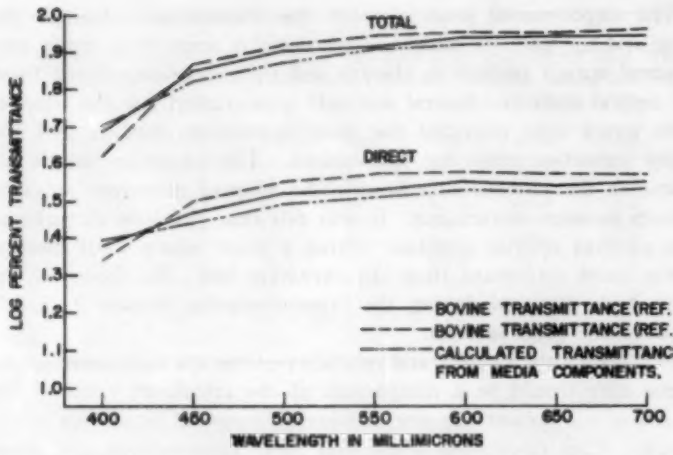

Fig. 4. Comparison of total transmittance of enucleated bovine eye[17] and calculated component media total transmittance with the data of DeMott and Davis.[5] The upper curves present the total transmittance and includes scatter. The lower or direct curves have been corrected for scatter.

the individual media components not experienced during total eye transmittance measurements. DeMott and Davis repeated their total transmittance measurements by using a scleral aperture slightly smaller than the retinal image size. They published a graph showing the relative scatter of light as a function of wavelength. This graph shows that scatter varies from 1.5 percent to 3.0 percent in the 400 mμ to 700 mμ wavelength range. If their data are used to correct for scatter, the lower curves, labeled "direct," of Figure 4 are the result. The direct curves give the transmittance of the bovine eye after correction for scatter. Figure 4 has been plotted with the abscissa as millicrons and the ordinate as the Log percent transmittance for better comparison of the data.

Boynton, Enoch, and Bush[3] reported a method for correcting transmittance losses due to post-mortem changes in excised eyes. Later, DeMott and Boynton[4] state that post-mortem changes are, "almost exclusively a function of dehydration of the cornea." They found continual bathing with a synthetic tear solution prevented such changes. The lens was expected to lose its transmission characteristics quite rapidly due to post-mortem changes. However, a preliminary study in which the lens was suspended in air for 2 hours showed no appreciable losses at 550 mμ. All bovine eye components were copiously bathed at regular intervals in a normal saline solution during experimentation.

Therefore, corrections for post-mortem changes were not made. Such corrections would result in a small increase to the transmittance readings.

SUMMARY

A method is presented for the measurement of the transmittance of the visible spectrum through the bovine eye media. The procedures used for the various media show that the largest amount of the visible spectrum is absorbed by the lens. Smaller amounts of the visible spectrum are absorbed by the cornea, vitreous and aqueous.

A comparison of the calculated component media transmittance with the total eye transmittance reveals only slight differences. The difference is attributed to the additional backscattering of the various components. It was estimated that the total data includes almost all the scattered light. Corrections for the scattered light were made from the data of DeMott and Davis. Post-mortem corrections were not made.

The bovine media data and the rabbit data of Kinsey show a remarkable likeness, the differences being attributed to globe size.

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The contents of this article reflect the personal views of the author and are not to be construed as a statement of Air Force policy.

OBITUARY

RALPH S. MINOR

Dr. Ralph S. Minor, 85, emeritus dean of the School of Optometry at the University of California and one of its founders, was found dead September 6, at his home, 2514 Cedar Street, Berkeley.

Death was believed due to a heart attack.

Dr. Minor, a native of Deposit, New York, took his Ph.D. at the University of Gottingen, Germany, in 1902. Except for a three-year period at the University of Nevada, he was a member of the University of California faculty from 1903 to 1946.

Dr. Minor served as dean of the School of Optometry from 1920 until his retirement in 1946. He was dean emeritus and professor emeritus of both physics and optometry. Minor Hall on the Berkeley campus is named in his honor.

Dr. Minor was an Honorary Life Fellow of the American Academy of Optometry.

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ACADEMY TO HONOR THREE FELLOWS

The American Academy of Optometry will honor Dr. Morris Steinfeld, Dr. J. Fred Andreae and Dr. D. G. Hummel at its Annual Meeting, December 9-12, 1961, at the Drake Hotel in Chicago. Drs. Steinfeld and Andreae will be awarded Honorary Life Fellowships during the banquet Monday evening, and Dr. D. G. Hummel will be awarded an Academy Special Merit Award on Sunday at the start of the Contact Lens Symposium.

Dr. Morris Steinfeld helped organize the Academy in 1921 and served as its first President. He was in private practice in Paducah, Kentucky, and during the first several years of the organization, did much to lay the groundwork of what is today a worldwide scientific society. Dr. Steinfeld practiced optometry for more than fifty years in his home city and now is retired and living in St. Petersburg, Florida.

Dr. J. Fred Andreae became Secretary of the Academy in 1927 and served in this capacity until 1943 when he was elected President of the Academy for a two year period. It was during Dr. Andreae's term as Secretary that the various departments and Sections of the present organization grew into their present full development. Dr. Andreae practiced optometry in Baltimore, Maryland, and more recently has moved his practice to Catonsville, a suburb of Baltimore. During his years of serving as Secretary of the Academy, he also became President of the American Optometric Association.

Drs. Steinfeld and Andreae will receive their Honorary Life Fellowships for their many splendid contributions to the Academy covering the past forty years.

Dr. D. G. Hummel, also a past President of the Academy will receive a Special Merit Award for his outstanding work in directing the Administrative Committee of the Academy Post-Graduate Courses during the first six years (1955-1960) these Courses have been offered to the profession. Dr. Hummel, with little to guide him, was called upon to arrange the sale and distribution of more than 15,000 hours of special instruction and it is due to his efforts that the present smooth working sales program of these courses is now in operation. Dr. D. G. Hummel is in private practice in Cleveland, Ohio.

On the following pages will be found the general program of the Academy as arranged by Dr. John Zettel, Jr., Chairman of the Papers and Program Committee. The programs of the five Academy Sections will appear in the November issue of this publication. The meeting will be held December 9-12 and the Post-Graduate Courses will precede the meeting on December 6-8. All events will take place at the Drake Hotel in Chicago.

CAREL C. KOCH

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

PROGRAM

AMERICAN ACADEMY OF OPTOMETRY

Drake Hotel
Chicago, Illinois

Post-Graduate Courses, December 6, 7 and 8, 1961
Annual Meeting of the Academy, December 9, 10, 11 and 12, 1961

WEDNESDAY, THURSDAY and FRIDAY, December 6, 7 and 8, 1961

8:00 A. M. to 10:00 P. M. American Academy of Optometry Post-Graduate Courses.* Apply at Registration Desk for tickets and Program. These courses are open to any optometrist.

10:00 A. M. to 5:00 P. M. American Academy of Optometry, Executive Council meetings. All Academy members welcome to attend sessions.

FRIDAY, December 8, 1961

9:30 A. M. to 5:00 P. M. American Academy of Optometry, Committee on Admittance.

GENERAL PROGRAM OF THE ACADEMY

Dr. John Zettel, Jr., General Chairman, Cincinnati, Ohio.

SATURDAY, DECEMBER 9, 1961

8:30 Registration

10:00 Business Meeting

President's Annual Report
Ralph E. Wick, O.D.

Secretary's Annual Report
Carel C. Koch, O.D.

Announcements by Chairman of the Papers and Program Committee
John Zettel, Jr., O.D.

Announcements by Chairman of the Sections under Direction of
Henry B. Peters, O.D., M.Sc.

*For a detailed review of these 83 courses see following: Vincent J. Ellerbrock *et al.* Post-Graduate Courses of the American Academy of Optometry. Am. J. Optom. & Arch. Am. Acad. Optom. 38.8.466-479.1961.

Section on Refractive Problems and Aniseikonia
William P. Schumann, O.D.
Section on Contact Lenses and Subnormal Vision Aids
Robert C. Graham, O.D.
Section on Public Health and Occupational Vision
Gayland F. Kintner, O.D.
Section on Binocular Vision and Perception
Max Schapero, O.D.
Section on Pathology
Arthur Shlaifer, O.D., Ph.D.

10:40 A. M.

THE RELATIONSHIP BETWEEN VISUAL ACUITY, CONTRAST SENSITIVITY, STRAY LIGHT AND AGE

Merrill J. Allen, O.D., Ph.D.
Division of Optometry
Indiana University
Bloomington, Indiana

This study is an effort to relate stray light, as estimated objectively with a photographic slit lamp arrangement, to the subjective visual acuity contrast relationship. Sixty-two subjects from 6 to 84 years of age were asked to judge the minimum contrast needed to see Landolt C targets from ½ to 6 minutes of arc at two illumination levels.

11:10 A. M.

THE CENTER OF ROTATION OF THE EYE

Glenn A. Fry, O.D., Ph.D.
Ohio State University
School of Optometry
Columbus, Ohio
Mr. W. W. Hill
Student
Ohio State University
School of Optometry
Columbus, Ohio

Experimental determinations have been made of the position of the primary line of sight and the pole of the cornea with respect to the head for different directions of regard in the horizontal plane. The significance of the data with respect to the concepts of center of rotation and fixation intercept have been studied.

11:40 A. M.

EXAMINING THE MENTALLY RETARDED CHILD

Elwood H. Kolb, O.D.
40 N. 8th St.
Allentown, Pa.

The procedure used in examining the eyes of a group of children that have been

diagnosed as mentally retarded will be outlined. An explanation of the clinic program making these examinations possible will be made. The results of the examinations of 96 such children will be broken down into various refractive and other categories that present themselves as the results are analyzed.

12:10 A. M. Luncheon Recess

1:15 P. M.

RELATIONSHIP BETWEEN REFRACTION
AT AGE SIX TO THAT AT AGE TWELVE
OJAI LONGITUDINAL STUDY — INTERIM REPORT

Monroe J. Hirsch, O.D., Ph.D.
School of Optometry
University of California
Berkeley, California

On the basis of analysis of the records of 12 examinations on 214 children, the refraction upon entering school is compared to the rate of changes during the first six years of school, and to the refractive state at the end of this period. A separate analysis of the changes during 6 years of school for the 19 children who entered school with marked hypermetropia is included.

1:45 P. M.

FACTORS EFFECTING THE SIZE OF THE BLIND SPOT OF MARIOTTE

Jerome M. McAllister
2403 Branard #2
Houston 6, Texas

Sponsored by:
Dr. Chester H. Pheiffer
Dr. Theodore P. Grosvenor
College of Optometry
University of Houston
Houston, Texas

Following the work of Davidson and others in the effects of toxicity on the Blind Spot of Mariotte, we have studied the effects of various variables on the size of the blind spot. In the paper two factors are discussed: (1) The breathing of oxygen and its effect on the blind spot. (2) The breathing of carbon dioxide and its effect on the blind spot. The results show that the percent constriction of the blind spot decreased in 89% of the cases after breathing oxygen for 5 minutes and increased in 84% of the cases after breathing carbon dioxide for 3 minutes.

2:15 P. M.

OCULAR EVALUATION IN BRAIN INJURY DIAGNOSIS

Michael J. Markow, O.D.
135 East Allegheny Ave.
Philadelphia 34, Pa.

At the Philadelphia Rehabilitation Center in Philadelphia we have been doing research in all phases of brain injury on in-patients and out-patients. We have found these phenomena: There are four major areas of the central nervous system which control life. (1) Spinal cord—medulla (2) pons (3) mid-brain—basal ganglion, and (4) cortex. Each of these major areas has its visual function. This is briefly (1)

spinal cord—medulla—reflex stage sees only light and dark. (2) Pons—vital stage—has perception of outline. (3) Mid-brain (basal ganglion) gnostic stage. Has perception of detail. (4) Cortex—stereo stage—seeing. Each stage has levels pertinent to that brain stage through which that part of the brain functions. Therefore, injury to any area or areas will embarrass a particular visual function or set of functions.

2:45 P. M.

PLEOPTICS, AS PRACTICED BY DRS. BANGERTER AND CUEPPERS

William P. Schumann, O.D.
Box 408
Vineland, New Jersey

Pleoptics is only now getting the attention it deserves. Bangerter in Switzerland opened his School for Amblieopybehandlung in Switzerland, and his results were encouraging for the amblyopic or strabismic child. Cueppers, in Giessen, Germany, followed his suggestion and opened a clinic at the Clinic of the University of Giessen. Cueppers is the inventor of new instruments for diagnostic and treatment purposes. Their use will be explained and the differences of their approach shown.

3:15 P. M.

A COMPARISON OF CORNEAL AND SCLERAL TONOMETRY—
A CLINICAL STUDY AT FORT JACKSON ARMY HOSPITAL

BY HOWARD A. DINSDALE, CAPT., M.C.
DAVID SIMON, 1ST LT., MSC.
Paul F. Shulman, O.D.
Illinois College of Optometry
3241 S. Michigan Blvd.
Chicago, Illinois

The authors, an ophthalmologist and an optometrist, each independently surveyed 200 eyes using the Schiotz Corneal Tonometer and the Wolfe Scleral Tonometer. The findings of the two were kept independent and later correlated by the medical statistical section. The comparison yielded a coefficient of correlation of + .80. The study has been approved for publication by the office of the Surgeon General in the ARMED FORCES MEDICAL JOURNAL.

3:45 P. M.

CRITERIA FOR COMPLETING A SUCCESSFUL CONTACT LENS CASE

Arnold L. Langsen, O.D.
Product Manager
Contact Lens Division
Univis, Inc.
Vision Park
Fort Lauderdale, Florida

There have been a number of articles in recent years concerning methods for objectively determining the correctness of the relationship between a contact lens and the cornea. The great number of points of view presented, many of them diametrically opposed, has lead to an almost chaotic state of confusion in the contact lens field. The great disparity of recommendations for lens design and fitting procedure, and the claim for success with all of these methods, suggest to the author an evaluation which will lead to criteria, common to all methods, for successfully completing a contact lens case.

4:15 P. M.

THE RELATIONSHIP BETWEEN ACCOMMODATION AND CONVERGENCE AND THE ELEVATION OF THE PLANE OF REGARD

Henry A. Knoll, O.D., Ph.D.
Ophthalmic Research and Development
Bausch & Lomb, Incorporated
Rochester 2, New York

The zero accommodation lateral heterophoria and response ACA ratio were measured with the plane of regard horizontal, elevated thirty degrees, and depressed thirty degrees. The data support the contention that esophoria is associated with downward gaze. The esophoria appears to be the result of greater accommodative response. The data do not support the contention that exophoria is associated with upward gaze. The response ACA ratio appears to be independent of the elevation of the plane of regard.

4:45 P. M.

A STUDY OF THE HAND KERATOSCOPE

John R. Levene
Diploma in Physiological Optics, London, England
Graduate Student
Indiana University
Division of Optometry

An investigation of the detection of corneal astigma by 30 optometrists using the Klein keratoscope on simulated corneas. The results are analysed to establish the detectability threshold and the overall liability of the instrument.

5:15 P. M.

THE RATE OF ESTABLISHMENT OF ACCOMMODATIVE POSTURE AFTER STIMULATION AND INHIBITION

C. B. Pratt, Ph.D., O.D.
Pacific University
Forest Grove, Oregon

Experimental observations with the cross cylinder technique are used to develop an equation expressing in exponential form changes at a series of time intervals after periods of maintained observation at dioptric stimulus levels greater and less than an eventually stable one. Extrapolation is used to determine the accommodative response to the original dioptric stimuli.

5:45 P. M.

THE RELATIONSHIP OF VISION TEST SCORES TO PISTOL TARGET SHOOTING

Thomas Madden, O.D.
Indiana University
School of Optometry
Bloomington, Indiana

Police shooting scores for the thirty-eight members of the Bloomington Police Department are evaluated in terms of refractive errors, age, numbers of years in police work, and hand dominance and eye dominance, in the evaluation. Special atten-

tion is given to the theory that clarity of the bead is more important than clarity of the targets.

6:15 P. M. Adjournment

SUNDAY, DECEMBER 10, 1961

9:00 A. M. Section Meetings

11:10 A. M.

THE FRACTURE RESISTANCE OF INDUSTRIALLY DAMAGED SAFETY GLASS LENSES

Henry B. Peters, M.A., O.D.
Associate Clinical Professor
School of Optometry
University of California
Berkeley 4, California

Safety glasses acquire numerous scratches, abrasions and pits in normal use in industry. Since these lenses are stressed in the heat-treating process it is important to know the effect of these defects on the impact resistance of these lenses. Using the standard drop-ball test, the impact resistance of industrially damaged plano safety glass lenses are compared to that for new lenses. A twelve per cent loss in impact resistance was found for even lightly scratched lenses. A forty-four per cent loss was found for those with pits and deeper scratches.

11:40 A. M.

THE VISION PART OF NIGHT DRIVING

Oscar W. Richards, Ph.D.
American Optical Co.
Research Department
South Bridge, Mass.

Driving an automobile properly depends on sensory information (mostly visual) and efficient coordination by the nervous and muscular systems. Accidents can result from any breakdown of this integration, or from failures in the car or highway system. Night driving adds the handicap of insufficient light for adequate seeing. An analysis will be presented of available basic information pertinent to the night driving problem and what can be done to improve seeing for night auto driving.

12:30 A. M. Luncheon Recess

1:45 P. M.

SPECIAL RECOGNITION TO DAN HUMMEL, O.D., CLEVELAND, OHIO, FOR HIS SIX YEARS SERVICE IN THE ADMINISTRATION OF POST-GRADUATE COURSES

Ralph E. Wick, O.D., President
American Academy of Optometry

2:00 P. M. to 4:30 P. M.

SYMPOSIUM ON CONTACT LENSES

2:00 P. M.

THE LATEST ENGLISH AND EUROPEAN CONTACT LENS TECHNIQUES

Frank Dickinson, President

British Optical Association
35, The Square
St. Annes-on-Sea, England

A review of the clinical techniques now in use in Europe.

AN ELLIPSOIDAL SURFACE CONTACT LENS

William Feinbloom, O.D., Ph.D.
105 East 35th Street
New York 16, N. Y.

Starting with Helmholtz's data showing the cornea as an ellipsoid, a method for making ellipsoidal surfaced contact lenses to fit this data is described. A clinical method of obtaining the data necessary to fit the proper equations in order to calculate the form of ellipse for an individual eye is presented. The clinic results in 100 cases fitted with ellipsoidal surfaced contact lenses are included.

CORRECTION OF APHAKIA WITH CONTACT LENSES

John C. Neill, O.D.
Pennsylvania State College of Optometry
Philadelphia, Penn.

A review of the clinical problems found in fitting these post-operative patients.

BIFOCAL CONTACT LENSES — A REVIEW

Harold I. Moss, O.D.
2106 Baynard Blvd.
Wilmington, Delaware

A review of the types of bifocal contact lenses and comment on the value of each.

WORLD WIDE SUMMARY OF CONTACT LENS TECHNIQUES

George Jessen, O.D.
5 S. Wabash Avenue
Suite 415
Chicago 3, Illinois

The letters of more than 20 prominent contact lens fitters from 6 continents and 19 countries excluding the United States are reviewed and summarized. The exchange of ideas and material is free from any restraint due to nationality, race, or political ideology. Research in science on a global level is the hope of mankind—and the desire to cooperate builds a bridge of friendship that will stand despite political differences.

PANEL DISCUSSION

4:30 P. M. to 5:00 P. M. Coffee Break

5:00 P. M.

VISUAL ACUITY IN RELATIONS TO EYE POSITION

Ronald W. Everson, O.D., M.S.
Indiana University
Division of Optometry
Bloomington, Indiana

The foveal visual acuity in each of the several positions to which the eye turns relative to the head is measured on 13 subjects. The fluctuations in acuity that were

observed are analysed in light of the hypothesis that foveal visual acuity is essentially constant over the field of fixation.

5:30 P. M.

REFRACTION PEDIGREES — COMMENTS ON HEREDITY AND ENVIRONMENT

R. J. Wixson, O.D.
8 W. Sunbury St.
Shamokin, Penna.

This paper attempts to trace the role of heredity in determining the refractive error. Refraction pedigrees of a series of families are traced through several generations in an attempt to see whether the refractive error is or may be inherited. Results of this study and others are correlated with respect to the effects which heredity and environment contribute to the development of the refractive error.

6:00 P. M.

THE EFFECT OF NEARWORK ILLUMINATION LEVEL ON MONKEY REFRACTION

Francis A. Young, Ph.D.
Department of Psychology
Washington State University
Pullman, Washington

Fourteen monkeys were split into three groups and each group was exposed to one of three levels of illumination inside translucent hoods which restricted visual space. In terms of amount of myopia developed there were no differences between the high and low level illumination groups but a significant difference was found between these groups and the medium illumination level group. Other comparisons between the groups and an attempt to explain these results are made.

6:30 P. M.

ACTIVITIES OF THE USAEHA IN THE FIELD OF VISION AND ALLIED AREAS

Major Richard R. Buckius
Chief,
Occupational Vision Branch
U. S. Army Environmental Hygiene Agency
Army Chemical Center, Maryland

That the Occupational Vision Branch of the U. S. Army Environmental Hygiene Agency assists in the initiation and maintenance of the Army Occupational Vision is well known. Not so well appreciated, however, are the various other visual activities which are entered into by the Occupational Vision Branch. The author reviews some of these activities including special visual studies in radar operations, lighting, and illumination. Projects to determine the practicality of glaucoma surveys and the optimal type of bifocal for gas mask inserts are also discussed.

7:00 P. M.

"CORRECTED CURVE" LENSES AND LENS QUALITY

John K. Davis
Product Development
American Optical Company

Southbridge, Mass.

There are many characteristics by which lens quality may be judged. Some of these are well understood as valid criteria for determining the acceptability of lenses as "first quality." There are other characteristics which are all but ignored. The term "corrected curve" itself has developed an aura of quality. This paper discusses "corrected curve" lenses and lens quality. Because there are different points of view regarding optimum lens designs, there has developed a variety of "corrected curve" lens series. However, some lenses are presented to the profession as "corrected curve" when neither the advertising or the product itself reveals the design philosophy. The advertising should indicate what it is that is corrected. The distribution of base curves on a surfacing chart is itself an indication of quality. The degree of correlation between the design and the performance of a finished lens is another facet of quality. The above points of view are discussed and illustrated with graphical presentations. The discussion is applied to spherical toric and aspheric lenses.

7:30 P. M. Adjournment

MONDAY, DECEMBER 11, 1961

9:00 A. M. Section Meetings

11:10 A. M.

NIGHT AND SPACE MYOPIA

Gordon Glenn Heath, O.D., Ph.D.
Indiana University
Division of Optometry
Bloomington, Indiana

This paper contains a description, investigation, and comparison of characteristics of night myopia and empty field myopia. The use of an infra-red retinoscope is discussed and was used for objective measurements of refractive statis over periods up to four hours under dark or empty field conditions. These measurements are compared with subjective measurements made at the same time.

11:40 A. M.

RECENT DEVELOPMENTS IN AUTOMOTIVE LIGHTING

Paul L. Connolly, O.D.
1148 S. Woodward
Royal Oak, Michigan

This paper will discuss the cooperative vehicle lighting research of the Automobile Manufacturer's Association. The improvement in road lighting from multiple headlights introduced in 1959 will be graphically presented. The new recommended code of dual intensity turn signals and stop lighting systems will be included. The next few years will bring many changes in the positioning of turn signals. There colors will be changed for better visibility. New instruments panel lighting is part of this coming standardization. This report of the cooperative research of American and European car manufacturers is a follow-up of the author's 1956 Academy lecture *"Visual Factors in Automotive Design and Engineering."*

12:10 A. M. Luncheon Recess

1:15 P. M.

RECENT RESEARCH FINDINGS ON THE RELATIONSHIP OF VISION TO READING ACHIEVEMENT

Lois Bing, O.D.
3550 Warrensville Center Road
Cleveland 22, Ohio

This paper will deal with the relationship between vision and reading. It will review generally the literature from 1950 to 1960 in optometry and in the allied fields of education, psychology and medicine. Recent research findings from a six year longitudinal study on the relationship of certain vision abilities to reading achievement will be reported. The data for this study were secured in the Euclid, Ohio, schools. It was analyzed statistically in the Statistics Laboratory of the Ohio State University.

1:45 P. M.

THE EFFECTS OF FIRST SPECTACLES ON
HIGH SCHOOL CLASSROOM PERFORMANCE

Edward R. Seefelt, O.D.
Graduate Student Physiological Optics
Indiana University
School of Optometry
Bloomington, Indiana

A study was conducted on 105 high school students to investigate the effects of the initial wearing of spectacles upon classroom performance. Grade scores received in the pre- and post-spectacle wearing semester were used as criteria.

2:15 P. M.

LIGHTING FOR EFFECTIVE SEEING

Sylvester K. Guth
Manager
A. A. Eastman
Radiant Energy Effects Laboratory
Neda Park
Cleveland 12, Ohio

The development of lighting recommendations for the wide variety of tasks encountered in the work world requires a consideration of many factors. While the number and complexity of these factors often is discouraging, it is possible to study them singly and in selected groups. Thus, one can assess their relative importance and applicability to specific visual situations. In this manner the basic visual skills such as size and brightness discrimination, the status of eyesight, the physical characteristics of visual tasks and visual environments, and the requirements of the job are combined to determine the conditions for most effective seeing.

2:45 P. M.

OPHTHALMOMETRIC CHANGES IN HIGH MYOPIA
VERSES CORNEAL CHANGES IN LOW MYOPIA

Wm. R. Baldwin, O.D., M.S.
Indiana University
Division of Optometry
Bloomington, Indiana

A longitudinal study of the keraetometric finding of high and low myops is made. The rate and direction of meridional changes are compared.

3:15 P. M.

SPECTACLES AS AN ADJUNCT TO OCULAR PROSTHESES

Stephen O. Bartlett, D.D.S.

Ralph L. Vasa, M.S.
U. S. Naval Medical School
Building 141, NNMC
Bethesda 14, Maryland

The use of spectacles as an adjunct to ocular prostheses is discussed. Five cases are presented. Color slides illustrate the effects.

3:35 P. M.

A NEURAL MECHANISM OF THE PURKINJE SHIFT

Leo E. Lipetz
Institute for Research in Vision
1314 Kinnear Road
Columbus 12, Ohio

The nerve impulses from a single ganglion cell of the isolated frog's retina (Rana catesbiana) were used as a measure of the response to illumination of various portions of the cell's retinal receptive field with a 100 micron diameter light spot. Illumination of any one portion of the receptive field caused a shift in maximum sensitivity toward longer wave lengths (Purkinje shift) in both the illuminated and the unilluminated portions of the receptive field. Stray light is insufficient to account for this, so a neurol mechanism, rather than bleaching of the receptors, must be involved.

4:00 P. M. Business Meeting

6:00 P. M. to 7:00 P. M. Cocktail Hour

7:00 P. M. Annual Round Table Dinner
Ralph E. Wick, O.D., presiding

Introduction of New Fellows
Harold Simmerman, O.D., Wenonah, New Jersey

Presentation of Honorary Life Fellowships to
Morris Steinfeld, O.D., and J. Fred Andreae, O.D.
by Carel C. Koch, O.D.

HAVE WORK — MUST DO
Don A. Frantz, O.D., President
American Optometric Association
DeKalb, Illinois

THE TEAM APPROACH TO AEROSPACE RESEARCH
Arthur B. Wentz, M.D., Chief
Clinical Research Branch
Aviation Medical Service
Washington, D. C.

Adjournment

TUESDAY, DECEMBER 12, 1961

9:00 A. M. Section Meetings

11:10 A. M.

EFFECT OF APERTURE SIZE OF VERGENCES

Frederick W. Hebbard, O.D., Ph.D.
School of Optometry
Ohio State University
Columbus 10, Ohio

Base-in and base-out prism vergences at 40 cm. were measured for four subjects over a period of one month, with aperture from 1 inch to ¼ inch diameter. Up to 60 sets of measurements per subject were taken. Also, prism vergences at 40 cm. were measured weekly for 3 months using a fixed aperture. The data were analyzed to determine the extent that aperture diameter affects prism vergences. The significance of the results on clinical testing is considered.

11:40 A. M.

EVALUATION OF A RAPID STEREOPSIS TEST

R. A. Koetting, O.D.
2730 Watson Road
St. Louis, Missouri
R. C. Mueller, O.D.
515 West Reed St.
Moberly, Missouri

The authors present an evaluation of a simplified depth perception test developed at the University of Indiana, Division of Optometry, by Dr. Henry R. Pardon with the cooperation of Dr. Henry W. Hofstetter. The device utilizes three 10 mm. spots placed at various distances before a shadowless illuminated plane. Recommended techniques are utilized and the results compared with the Wirt Stereotest, the Keystone DB Telebinocular stereopsis test, and the depth perception test in the standard American Optical Company Industrial Sight Screener. The new test is a pass-fail type, and the paper attempts to show how results can be compared with accepted "in office" methods of measuring stereopsis. The paper includes a summary of findings and suggested procedures for use of the new instrument.

12:10 A. M. Luncheon Recess

1:10 P. M.

EFFECTS OF SYSTEMIC DISEASES UPON VISION —
PART I — DISEASES OF THE UNUSED TRACT

Theodore P. Grosvenor, Ph.D.
Associate Professor of Optometry
University of Houston
Cullen Boulevard
Houston 4, Texas

This paper is the first of a series of papers dealing with the effects of systemic diseases upon the visual apparatus. It will include a survey of the recent literature concerning the relationships between diseases of the uveal tract and systemic diseases, with emphasis on the role of the optometrist in the detection and referral of such cases.

1:40 P. M.

THE QUANTITATIVE ESTIMATION OF VISION — HISTORICAL REVIEW

Vernon Ryan, O.D.
Pennsylvania State College of Optometry
6100 N. 12th St.
Philadelphia 41, Pa.

The quantitative estimation of vision is treated under three headings, central vision, peripheral vision, and ocular motility. This theme is the medico-legal aspect in relation to visual loss. During the period 1860-1960 there have been many attempts to find an acceptable solution to the problem of evaluating the amount of total vision possessed by any individual. A historical review attempts to show how our thinking has undergone evolutionary changes. Time would only permit a reading of the section entitled "Central Vision."

2:10 P. M.

UNDERCORRECTION OF MYOPIA AND THE ACA RATIO

Merton C. Flom, O.D., Ph.D.
Ellen Takahashi, M. Opt., O.D.
School of Optometry
University of California
Berkeley, California

Nearpoint esophoria, frequently observed in undercorrected myopes when fully correcting during examination, has been used as justification to undercorrect myopia. The present study confirms the frequency of nearpoint esophoria in these myopes. In nearly all of the experimental subjects there was a decrease haploscopically measured ACA ratio after wearing the full minus correction for about one week. Implications regarding the permanence and clinical significance of the observed changes are discussed.

2:40 P. M.

PUPILLOGRAPHY

Richard Feinberg, Ph.D.
Chief Visual & Auditory Section AM-12
Aviation Medical Services

This paper will review the history and modern technique in recording and analyzing the pupillary diameters of the two eyes under controlled conditions. It will indicate the uses of pupillography in psychoneural research, detection of fatigue and aging and diagnostic research. Normal pupillary responses will be illustrated as well as those presenting specific changes in response patterns as a result of irritative or destructive changes in the nervous system.

3:10 P. M.

THE UTILIZATION OF HAIDINGER BRUSHES IN ORTHOPTICS

Bernard E. Vodnoy, O.D.
801 North Michigan St.
South Bend 1, Indiana

This paper will cover the use of the Haidinger Brushes as a diagnostic means for testing for eccentric fixation and an outline of the responses which patients may experience in the use of this treatment.

Secondly, it will set forth the use of transparent slides placed before the Haidinger Brushes, such as the Snellen Chart, or airplane, so that as a patient trains to develop form recognition of smaller and smaller letters, the Haidinger Brushes will tell him whether he is on macula or off macula, as he is attempting to develop form perception.

3:40 P. M.

A NEW SUBSTANCE FOR CONTACT LENSES

Robert Morrison, O.D.
Green and Division Streets
Harrisburg, Pennsylvania

A new material has been developed for contact lenses. Until now the plastic used was methyl methacritate, this only incidentally worked for contact lenses and left much to be desired. This new material has been accepted by leading authorities all over the world. It has a higher index refraction (1.57). All lenses can be flatter. (By dropping a HyFrax lens and a conventional lens in water and then re-reading the curves a few days later the HyFrax will still be the same and the regular lens flatter.) After wearing lenses on the eye the flattening can almost always be easily measured. This is a great scientific breakthrough in our opinion as the flatter lens will later tend to rub the corneal epithelium and cause some breakdown of the tissue. The plastic has other features which I would like to discuss. Colors are now non-toxic which is also a new development. Although chemists, laboratory technicians, engineers were on our research team this development is basically an optometric one.

4:10 P. M.

VISUAL ASPECTS OF SPACE FLIGHT

Floyd M. Morris, O.D.
Lt. Col. USAF (MSC)
School of Aerospace Medicine
Brooks Air Force Base, Texas

The potential visual problems associated with orbital and space flight are discussed. Special emphasis is given to the visual environment to be encountered by the astronaut both outside the space vehicle and within the cabin. Attention is also focused on the retina-burning power of the sun outside the earth's atmosphere. Speculation as to the effect of weightlessness on the visual apparatus as well as a discussion of space myopia is also included.

4:45 P. M. Adjournment

NEW MEMBERS

The following optometrists and educators have been elected Fellows of the American Academy of Optometry. The Executive Council welcomes these new members.

Dr. Stanley N. Abrams, Regina Medical Centre, 1847 Rose Street, Regina, Saskatchewan, Canada.

Dr. Lynn D. Allen, Jr., 810 Community Bank Building, Pontiac, Michigan.

Dr. Millard H. Allen, 3216 Reid Drive, Suite A, Corpus Christi, Texas.

Dr. Marcel Chiquiar Arias, Ave. Insurgentes Sur 403, Mexico 11, D. F.

Dr. Victor Chiquiar Arias, Insurgentes Sur No. 107, Mexico 6, D. F., Mexico.

Dr. Frederick U. Baublitz, 112 Broad Street, Martinsville, Virginia.

Dr. Ramon Burstyn, 6009A Burnet Road, Austin, Texas.

Dr. Clifford W. Childress, 223 East Washington, Greensburg, Indiana.

Mr. John Clenton, 30, Albert Street, Mansfield, Notts, England.

Dr. Rene G. Desaulniers, 11 Broad Street, Danielson, Connecticut.

Dr. Gerald C. Elliott, 25 South Vine Street, Greencastle, Indiana.

Dr. Alfred A. Fontana, Terminal Medical Building, 7035 West Grand Avenue, Chicago, Illinois.

Dr. Kenneth Y. Fujimoto, 1234 Waimanu Street, Honolulu, Hawaii.

Dr. J. Pedro Handal, Apartado Postal No. 5, Tegucigalpa, D. C., Honduras, C. A.

Dr. Joseph J. Hanna, 5128 North Broad Street, Philadelphia, Pennsylvania.

Dr. F. Carter Haydon, 104 Vassar Drive S. E., Albuquerque, New Mexico.

Dr. George R. Leach, Sowka Clinic, 745 Main Street, Stevens Point, Wisconsin.

Dr. Thomas M. Madden, 1225 Maxwell Lane, Bloomington, Indiana.

Dr. Arthur M. Mandel, 5 South Wabash Avenue, Suite 415, Chicago, Illinois.

Dr. Gerald Mulrooney, 284 Quinpool Road, Halifax, Nova Scotia, Canada.

Mr. Thomas C. Oglethorpe, 18, Bridge Street, Morpeth, Northumberland, England.

Dr. George A. Pena, 948 North Krome Avenue, Homestead, Florida.

Dr. Emanuel Pushkin, 1353 Coral Way, Miami, Florida.

Dr. Robert W. Ridley, 5428 South Kimbark, Chicago, Illinois.

Mr. David L. Roslyn, 22 High Street, Tooting, London S.W.17., England.

Dr. V. H. Small, Purdue University Center, Jefferson and Barr Streets, Fort Wayne, Indiana.

Dr. B. Botious Sullivan, 2914 East Central Avenue, Wichita, Kansas.

Dr. Arthur W. Thomas, 8421 Lincoln Boulevard, Los Angeles, California.

REPORT ON LONDON CONGRESS

The International Ophthalmic Optical Congress held at the University of London Union this July from the 5th through the 12th was truly international in that there were nearly 700 registered delegates from Australia, Belgium, Canada, Ceylon, Chile, Cyprus, Czechoslovakia, Denmark, Eire, France, Germany, Great Britain and Northern Ireland, Greece, Grand Canary, Hungary, India, Iraq, Israel, Italy Jersey (C. I.), Kenya, Netherlands, New Zealand, Nigeria, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Turkey, United Arab Republic, and the United States of America.

The Congress was opened right on schedule by its President, Mr. C. S. Flick, F.A.A.O. The principle speaker of the opening ceremony was the Right Honorable Enoch Powell, M.P., Minister of Health. Mr. Powell welcomed the delegates on behalf of Her Majesty and then briefly reviewed the National Health Service, which he said was always of interest to overseas visitors. He pointed out that the service was now some 13 years old and that during this time more than 60 million eye tests had been given under the Service—some 85% by the optometrists of Britain and Northern Ireland. According to Mr. Powell this was a very gratifying aspect of the health service, particularly to Her Majesty's Government, in that it rendered a needed and very worthwhile service and yet created little or no controversy.

The papers program proved to be a real "three ring circus"—papers were read in three lecture rooms of the Union simultaneously. In all, nearly 75 papers on a great diversity of topics were read. The one single field which received the most attention was that of contact lenses. There was a nice balance between theoretical and practical papers. One aspect of the sessions deserves special mention: On Sunday, July 9th, no papers were read; instead the delegates were urged to attend church services.

The main social affair of the Congress was a banquet at the Savoy Hotel on Monday evening, July 10th. After the Toast to Her Majesty, The Queen, Professor Henry Hofstetter upheld the honor of the U. S. in his Toast to the Congress.

Another social affair of special importance to the Fellows of the American Academy of Optometry was a reception and cocktail party held at English Speaking Union by the British Chapter "to meet: American Colleagues" on July 11th. Needless to say there was an ample supply of tidbits of all varieties: liquid, solid, and verbal. The reception was concluded with a word of greeting and farewell from Mr.

Flick, President of the Congress. Professor Vincent Ellerbrock responded and brought the greetings and thanks of Ralph Wick, president of the American Academy of Optometry.

The Congress was concluded by two symposiums. On July 11 there was a symposium at the London Refraction Hospital on "Recent Advances in the Treatment of Strabismus" and on July 11 and 12 there was another at Northampton College on, "Objectives and Methods in Ophthalmic Optical Education."

Obviously it would have been impossible for any one person to attend all sessions, let alone summarize the papers. The committee plans to publish the papers in a "Transactions," which should be available toward the end of the year.

MEREDITH W. MORGAN

HAWAII CHAPTER

The Hawaii Chapter held an organizational meeting on September 12, 1961. The following officers were elected. Dr. Yim Kai Look, president. Dr. Kenneth Y. Fujimoto, vice president and Dr. George J. Buto, secretary-treasurer. All officers practice in Honolulu.

ACADEMY POST-GRADUATE COURSES

Advance registration tickets may now be ordered for the 83 Post-Graduate Courses to be given in Chicago, Illinois, December 6, 7 and 8, 1961, at the Drake Hotel. An outline of these courses with an order form will be found on pages 466-479 of the August, 1961, issue of this publication. Interested optometrists may write to the American Academy of Optometry, 1506-1508 Foshay Tower, Minneapolis 2, Minnesota, requesting a free 16-page booklet giving all necessary information. Advance registration is advised and the courses are open to all optometrists.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

THE CASE AGAINST CASES

Dr. Monroe J. Hirsch, associate editor of this publication says, an editor isn't a persnickety, fault-finding curmudgeon — at least, not until he has been an editor for a few days. Then, special oft-repeated errors promote peevishness in him, and the editor becomes a crank. We're a crank about the use of the word "case."

A patient is not a case. A patient is an individual. If he serves in an experimental situation, he is a subject. He is a person. He is a man (except when he is a woman or child), but he is *not* a case.

It was a dark day for editors of scientific literature when the first case appeared. Dictionaries define a case, as it applies to the healing arts, as "a single instance or example of a disease," but authors constantly try to make it refer to an individual.

Properly, case refers to the totality of the symptoms and of the pathologic and other conditions. The unfortunate human being who has the disease or anomaly is a patient and, in spite of his erratic behavior signs, he is never a case.

Almost always when case appears in a manuscript it is used incorrectly. We read: "The case had esophoria," or "I saw a case with myopia," or "20 cases were given orthoptics." The word is misused so often that most authors might do well to avoid using it ever. If most authors changed the word "case" to "patient" consistently, they would be correct more often than not. The number of editorial changes would be cut tenfold.

Sometimes case is not used as a synonym for patient but is simply a "bum." A bum in editorial jargon is an unnecessary word. If the bum is deleted, the sentence is shorter and as meaningful or more meaningful. For example, "the patient was recovering from a case of measles" is improved by deleting "a case of" to leave "the patient was recovering from measles."

Lest authors regard this editorial note as evidence of the picayune nature of editors, let us note that more than grammar is involved. Although clinicians seek general principles from an individual patient under study, the individual under scrutiny is immediately important. In practice the individual must be treated as an individual for he is an

individual. This should be so deeply ingrained within us that we never think "case" but think "patient," for we write as we think.

In clinical practice or in writing the patient is not a case. He is not a statistic. He is an individual. He is the reason for our professional existence.

PENNSYLVANIA STATE COLLEGE OF OPTOMETRY

Governor David L. Lawrence of Pennsylvania has signed a College appropriation bill for the Pennsylvania State College of Optometry in the amount of $50,000 for the current fiscal year. The House Bill 1431 setting up this action was as follows: An Act making an appropriation to the Pennsylvania State College of Optometry, Philadelphia, Pennsylvania for maintenance and support. The General Assembly of the Commonwealth of Pennsylvania hereby enacts as follows: Section 1. The sum of Fifty Thousand Dollars ($50,000) or as much thereof as is necessary is appropriated to the Pennsylvania State College of Optometry, 6100 North 12th Street, Philadelphia, Pennsylvania for the fiscal period beginning June 1, 1961, for the general maintenance of the college and the purchase of such supplies, apparatus and equipment as the trustees may deem necessary for the best interest of the college.

BVI RETAINS KOHLER FOR PROFESSIONAL COMMUNICATIONS

The Better Vision Institute has retained Albert A. Kohler Company, Inc., Old Greenwich, Connecticut, advertising agency, to handle creative and other services on professional and trade communications in connection with the BVI's Better Vision Program to educate the public to the need for regular complete professional eye examination.

Kohler Company has long been active in ophthalmic promotion and advertising and currently handles professional and trade promotion for a number of ophthalmic organizations.

Consumer advertising for the Better Vision Institute is handled by Doherty, Clifford, Steers & Shenfield, Inc., New York City.

1962 CONGRESS IN WEST BERLIN

The 1962 International Ophthalmic Optical (Optometric) Congress will be held in West Berlin, Germany, on May 28 to June 2. It is anticipated that optometrists from over 50 countries will be in attendance, including optometrists from behind-the-iron-curtain countries. The International Optical League, in which both the American Optometric Association and the American Academy of Optometry hold membership, will also schedule business meetings during the Congress period. The dedication ceremonies for the fabulous new building for the Berlin optometry school will be on the Congress program schedule.

The famous new Berlin Congress Hall (dubbed the "pregnant

oyster" by Berliners!) will be the headquarters for all of the Congress activities, including an outstanding exhibition of ophthalmic products and equipment. Excellent modern hotels have been booked for the occasion.

The preparations for the Congress are being made by "Zentralverband der Augenoptiker" (Fürstenwall 135, Düsseldorf, 22 a, West Germany) in cooperation with the Augenoptikerinnung Berlin (Eislebener Strasse 3, Berlin W 30, Germany). American optometrists wishing to attend or to submit papers for the program may make inquiries or reservations by writing to either of those addresses.

RESEARCH FELLOWSHIPS —
NATIONAL COUNCIL TO COMBAT BLINDNESS

The National Council to Combat Blindness, Inc., announces that the closing date for receipt of completed applications for full-time research fellowships, grants-in-aid and student fellowships for the 1962-63 period is March 1, 1962.

In general, notification to applicants for full-time research fellowships and grants-in-aid will go forward in July with September 1 as the commencement date for the project. Under special circumstances, where earlier notification is judged essential, the Scientific Advisory Committee may consider applications in advance of the scheduled date, but in no event will they be considered for commencement prior to May 1.

Applicants for student fellowships will be notified in May of the action taken by the Scientific Advisory Committee in order that arrangements may be made with their respective institutions to commence work in early Summer.

Application forms and information outlining the conditions under which these awards are made may be obtained by addressing: Secretary, National Council to Combat Blindness, Inc., 41 West 57th Street, New York 19, N. Y.

The National Council to Combat Blindness, Inc., was founded in 1946 with the primary purpose of financing research in ophthalmology and related sciences. The objective of its program is the ultimate reduction of blinding eye diseases and ocular disorders, through increased basic and clinical research in the field of scientific investigation.

Grants and fellowships approved at the June, 1961, meeting of the organization's Scientific Advisory Committee will be announced as soon as all official acceptances have been received.

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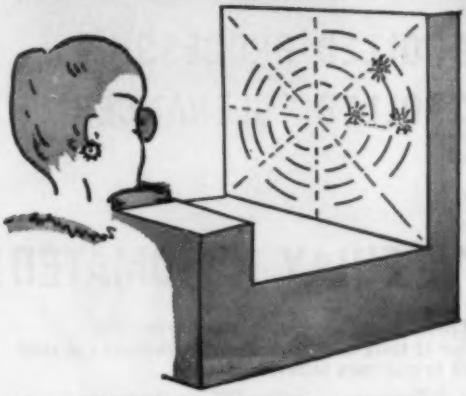

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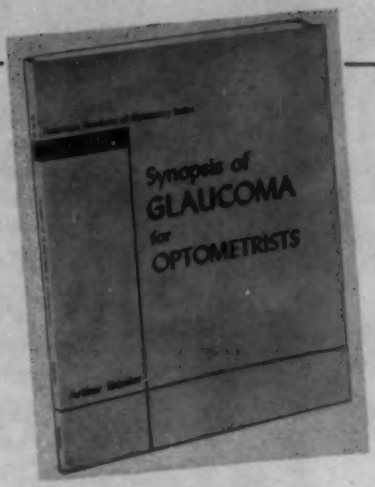

Now in its Second Printing

SYNOPSIS of GLAUCOMA for OPTOMETRISTS

Arthur D. Shlaifer
O.D., Ph.D., F.A.A.O.
Pennsylvania State College of Optometry

Reviewers say:

"This book is must reading and could well be used as a standard text in our optometric schools and colleges.

". . . the book is written in straightforward, easy to read English . . ."

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Journal of the American Optometric Association

"This book fills a long felt need in optometry. The phenomenal sale of this volume indicates that thousands of other optometrists will equally benefit by owning and using it regularly. The book should be read and then kept in full view in the refracting room where its presence on the desk of the optometrist will do much to assure patients who are apprehensive regarding this pathology.

CAREL C. KOCH
Secretary F.A.A.O.
American Journal of Optometry

Contents • anatomical and physiological considerations • symptoms and clinical picture • ophthalmoscopy • gonioscopy the intraocular pressure • tonometry visual fields • etiology • the treatment of glaucoma • pathology • miscellany • a summary of optometric tests for the detection of glaucoma

Usable for both the practicing optometrist and in the classroom, this book is the first in a series of home study courses, published by the American Academy of Optometry, intended to round out its work in postgraduate education. The author is a practitioner as well as an educator. His work covers etiology, clinical signs, symptoms and screening tests used to facilitate the understanding of glaucoma detection and referral.

The subject matter is designed to present the noticeable features of glaucoma to facilitate detection by the optometrist, and subsequent referral to an ophthalmologist.

In addition to this information, all aspects of the disease are covered so that the optometrist will be familiar with procedures used by the ophthalmologist in treating cases which he has referred.

Now in its second printing, Synopsis of Glaucoma for Optometrists is being used in a number of postgraduate study courses. Optical distributors and manufacturers of ophthalmic supplies throughout the country have been successfully selling the book.

It treats the subject matter authentically, briefly, yet completely, according to the American Academy of Optometry requirements.

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